16 JANUARY 1980 (FOUO 2/80) 1 OF 1

JPRS L/8867

16 January 1980

# USSR Report

## RESOURCES

(FOUO 2/80)

FBIS FOREIGN BROADCAST INFORMATION SERVICE

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

For further information on report content call (703) 351-2938 (economic); 3468 (political, sociological, military); 2726 (life sciences); 2725 (physical sciences).

JPRS L/8867

16 January 1980

# USSR REPORT

## RESOURCES

(FOUO 2/80)

CONTENTS PAGE

ELECTRIC POWER AND POWER EQUIPMENT

## THE DEVELOPMENT OF DISTRICT HEATING IN THE USSR

Razdan RAZVITIYE TEPLOFIKATSII V SSSR in Russian Sep 78 pp 1-27

[Article by Yefim Sokolov, doctor of technical sciences, and Vasiliy Korytnikov, from the Joint Soviet-American Symposium on Distribution of Heat from Thermoelectric and Nuclear Power Plants]

[Text] 1. Power Engineering Principles and Effectiveness of the Combined Method of Producing Heat and Electric Power

Out of all forms of generated energy, two of them are the most widespread at the present time -- heat and electricity -- for the generation of which the USSR expends about half of all of its extracted fuel and energy resources.

Important significance is attached to electric power which in the modern world plays the leading role in the development of the productive forces of society.

The significance of electrification for all-around progress in the USSR was expressed in the famous formula of V. I. Lenin: "Communism Equals Soviet Power Plus Electrification of the Entire Country."

With respect to the scale of the development of electrification the Soviet Union has made enormous progress in a short period of history. From one of the last places in the development of power engineering in Europe, the USSR has risen to first place in Europe and second (after the United States) in the world.

In 1913, that is, on the eve of World War I, the electric power production in Czarist Russia amounted to 1.95 billion kilowatt-hours.

In 1920, that is, at the time of approval of the State Plan for the Electrification of Russian (the GOELRO Plan), the electric power production in the country had dropped to 0.5 billion kilowatt-hours.

In 1977 the USSR generated 1150 billion kilowatt-hours of electric power, that is, 590 times more than in 1913. More than 20% of all of the fuel and energy resources extracted in the country were expended on producing electric power in 1977.

With respect to the annual electric power output per capita the USSR is now on the level of the highly developed European countries and Japan. In 1977 this index was about 4400 kilowatt-hours/man-year in the USSR.

The basis for Soviet electrification has been thermal electric power plants which generate about 87% of all of the electric power.

Medium and low-potential heat[1] is a second form of energy widely used in the national economy and at home.

In 1976 more than 10 billion gigajoules[2] (2.4 billion gigacalories) of heat were produced for heating, ventilating and hot water supply of residential, public and industrial buildings, for which about 25% of all of the fuel and energy resources extracted in the country were expended.

The consumption of electric power in the USSR has approximately doubled every 12 to 13 years, and the heat consumption has doubled approximately every 15 to 18 years.

In 1980, the generation of electric power in the USSR will reach 1340 to 1380 billion kilowatt-hours. The consumption of low and medium-potential heat will be about 12 billion gigajoules according to preliminary data (2.9 billion gigacalories). Eighty percent of this heat is to be generated at the centralized sources (the heat and electric power plants and the large boiler plants).

The basic primary resource for generating electric power and heat is at the present time organic fuel. In the near future (10 to 15 years) the use of nuclear fuel will be significant in addition to organic fuel.

District heating has especially important significance in the organization of efficient power supply for the country. It is the most modern method of centralized supply of heat and one of the basic means of increasing the thermal economy of electric power production.

The term district heating means the centralized supply of heat based on combined, that is, joint generation of heat and electric power.

The combined generation of heat and electric power is the primary distinction of district heating from the so-called separate method of supplying heat where the electric power is generated at condensation thermal electric power plants, and the heat is generated in boiler plants.

---

[1]Heat with a temperature level to 150°C is considered low-potential; with a temperature level from 150 to 350°C it is considered medium-potential.

[2]1 gigajoule = 0.239 gigacalories.

The primary power engineering effect from district heating consists in the replacement of heat generated for separate power supply in the boiler rooms by the exhaust heat picked up from the thermal power cycle of the electric power plant, as a result of which the useless discharge of heat to the environment during the conversion of energy of burned fuel to electric power is eliminated at the electric power plant. When using district heating, the source of generation of the electric power and heat is the heat and electric power plant (TETs). The heat of the working medium (steam or gases) at increased potential (having high temperature and pressure) is first used to generate electric (mechanical) power in the turbine; then the heat of the spent working medium, which has lower potential, is used for centralized supply of heat. By using this combination method, the specific heat consumption for the generation of electric power is appreciably less than for separate generation of electric power and heat where the heat of the working medium spent in the turbines is discharged to the environment and lost uselessly.

The ideal Carnot cycles of steam electric power plants -- condensation (Fig 1a) and district heating (Fig 1b) -- are illustrated in the T-S diagram in Fig 1.

$T_b$ is the mean temperature of the heat input to the cycle; $T_H$ is the mean temperature of the heat removal from the district heating cycle; $T_{o.c}$ is the ambient temperature.

The amount of supplied heat is identical in the two cycles, and it is equal to

$$q_n = T_b \Delta S \qquad (1)$$

The amount of work obtained is as follows:

in the condensation cycle

$$l_k = (T_b - T_{o.c}) \Delta S \qquad (2)$$

in the district heating cycle

$$l_T = (T_b - T_H) \Delta S \qquad (3)$$

The amount of exhaust heat usefully employed for the heat supply is as follows:

in the condensation cycle

$$q_k = 0 \qquad (4)$$

in the district heating cycle

$$q_T = T_H \Delta S \qquad (5)$$

The specific heat consumption for obtaining work is as follows:

in the condensation cycle

$$q_K^P = \frac{q_\Pi}{e_K} = \frac{\frac{T_b}{T_{o.c}}}{\frac{T_b}{T_{o.c}} - 1}\ ; \tag{6}$$

in the district heating cycle

$$q_T^P = \frac{q_\Pi - q_T}{e_T} = 1\ ; \tag{7}$$

The specific combined generation, that is, the number of units of work obtained in the district heating cycle per unit of exhaust heat is as follows:

$$Э_T = \frac{e_T}{q_T} = \frac{T_b}{T_H} - 1\ ; \tag{8}$$

The specific saving of heat per unit heat released from the district heating cycle is

$$\Delta q = Э_T\left(q_K^P - q_T^P\right) = \frac{T_b - T_H}{T_b - T_{o.c}} \cdot \frac{T_{o.c}}{T_H}\ . \tag{9}$$

As is obvious from equation (9), the specific saving of heat as a result of the combined generation increases with an increase in temperature $T_b$ of supplying heat to the cycle and with a decrease in temperature $T_H$ of the removal of heat from the cycle.

The specific combined generation in real steam district heating units considering the irreversible losses is illustrated in Fig 2.

The combined generation of electric power is in the USSR one of the basic methods of continuous (from year to year) reduction of the specific fuel consumption for the generation of electric power. The proportion of the combined generation of electric power at the heat and electric power plants increases from year to year. In 1976 it was on the average 65% of the total generation of electric power at the general-purpose heat and electric power plants, that is, the heat and electric power plants forming part of the system of the USSR Ministry of Power.

At the present time the general-purpose heat and electric power plants amount to 88% of all of the heat and electric power plants in the country with respect to the installed electric power and 73% with respect to the annual heat output.

The specific saving of provisional fuel[1] at the heat and electric power plants as a result of the combined generation of electric power is at the present time $\Delta q$=12 kg/gigajoule or about 30% of the fuel consumption for generation of heat in the modern high-economy boiler plants.

The saving of provisional fuel as a result of the combined generation of electric power at the general-purpose heat and electric power plant was about 30 million tons in 1976, or about 11% of the total fuel consumption for the generation of electric power at all of the general-purpose thermal electric power plants, that is, at all of the thermal electric power plants of the USSR Ministry of Power.

Fig 3 shows the dynamics of the variation of the specific consumption of provisional fuel (net) at the general-purpose thermal electric power plants of the USSR in the last 15 years from 1961 to 1976 and also the specific fuel consumption in 1980 expected by the expert evaluation of the author.

In the last 15 years the mean specific consumption of provisional fuel (net) at the heat and electric power plants decreased by 190 g/kilowatt-hour from 462 to 272 g/kilowatt-hour. In spite of the significant progress also in the field of thermal economicalness of the condensation electric power plants, the difference in the mean specific fuel consumption of the condensation electric power plants and the heat and electric power plants during this period has increased continuously and reached 91 g/kilowatt-hour in 1976. It is possible to assume that in 1980 this difference will be approximately 100 g/kilowatt-hour.

The mean specific consumption of provisional fuel (net) with respect to all of the general-purpose thermal electric power plants decreased by 122 g/kilowatt-hour in 15 years, from 459 to 337 g/kilowatt-hour. In the indicated reduction of the mean specific fuel consumption, 84 g/kilowatt-hour was obtained as a result of the heat and electric power plants, that is, 69% of the total reduction. Table 1 gives some power engineering indexes characterizing the development of district heating from the general-purpose heat and electric power plants during the period from 1960 to 1976.

In the investigated period, the generation of electric power at the general-purpose heat and electric power plants increased by 4.1 times from 66 to 271 billion kilowatt-hours. The specific combined generation of electric power per unit exhaust heat increased by 1.7 times from 174 to 293 kilowatt-hours/gigacalorie. The combined generation of electric power at the heat and electric power plants increased by 8.3 times from 21 to 174 billion kilowatt-hours. The proportion of the combined generation in the total electric power output at the heat and electric power plants increased from 32 to 65%, that is, it doubled.

---

[1] The heat of combustion of a provisional fuel is 7000 kcal/kg=29300 kjoules/kg.

As a result of the broad development of district heating and the general technical progress of the condensation electric power plants, at the present time the USSR holds first place in the world together with France with respect to thermal economicalness of electric power production, surpassing England, United States, the Federal Republic of Germany and other developed countries.

The specific fuel consumption for the production of electric power in the USSR is decreasing systematically from year to year.

The mean specific fuelconsumption (net) at the general-purpose plants of the USSR was 340 g/kilowatt-hour in 1975, 337 g/kilowatt-hour in 1976, and 334 g/kilowatt-hour in 1977.

In 1975 the specific fuel consumption (net) was equal to 333 g/kilowatt-hour in France, 341 g/kilowatt-hour in the Federal Republic of Germany, 370 g/kilowatt-hour in the United States, and 374 g/kilowatt-hour in England.

Two basic principles of efficient power supply are realized in district heating:

a) The combined production of heat and electric power at the heat and electric power plants;

b) Centralization of the heat supply, that is, the supply of heat to numerous heat users from one source.

The essence of the first principle -- the combined production of electric power and heat, which is a specific characteristic of district heating -- was investigated above.

The second principle -- centralization of the heat supply -- is not a characteristic feature inherent only in district heating. The centralization of the heat supply can be realized only when supplying heat from the heat and electric power plants, but also when supplying heat from other sources, for example, large boiler plants or industrial exhaust heat devices.

The centralization of heat supply in itself also usually results in saving fuel as a result of higher efficiency of the large boiler plants, and especially the powerful modern boiler heat and electric power plants by comparison with the local boiler plant, in spite of the additional heat losses in the networks in the case of a centralized heat supply.

The centralization of heat supply promotes the provision of the district supplied with heat with amenities, it improves the comfort of the heated buildings, it lowers the labor consumption for servicing the heating facilities of these cities and industrial areas.

Table 1

Development of District Heating from General-Purpose Plants in the period from 1960 to 1976

| Indexes | Dimensionality | 1960 | 1965 | 1970 | 1975 | 1976 |
|---|---|---|---|---|---|---|
| Installed electric power of the district heating turbines | million kwt | 11.9 | 23.7 | 36.9 | 49.1 | 52.1 |
| | relative units | 1.0 | 1.99 | 3.1 | 4.14 | 4.4 |
| Generation of electric power by the district heating turbines | billion kwt-hr per year | 66 | 135 | 195 | 256 | 271 |
| | relative units | 1.0 | 2.05 | 2.96 | 3.88 | 4.1 |
| Generation of electric power by the combined method | billion kwt-hr per year | 21 | 55 | 105 | 158 | 174 |
| | relative units | 1.0 | 2.62 | 5.0 | 7.5 | 8.3 |
| Proportion of combined generation of electric power at the heat and electric power plants | %% | 32 | 40.8 | 54 | 61.7 | 64.4 |
| Heat output from the heat and electric power plants | billions of gigajoules/yr | 0.61 | 1.29 | 2.14 | 2.65 | 2.9 |
| | relative units | 1.0 | 2.12 | 3.5 | 4.35 | 4.75 |
| Including the exhaust heat | billions of gigajoules/yr | 0.5 | 1.05 | 1.76 | 2.3 | 2.5 |
| | relative units | 1.0 | 2.1 | 3.52 | 4.6 | 5.0 |
| Specific combined generation of electric power per unit of exhaust heat | | 0.15 | 0.188 | 0.215 | 0.247 | 0.252 |
| | kilowatt-hr/gigajoules | 41.6 | 52.1 | 59.6 | 68.5 | 70 |
| | kilowatt-hr/gigacalorie | 174 | 218 | 250 | 288 | 293 |
| | relative units | 1.0 | 1.25 | 1.43 | 1.64 | 1.68 |

District heating is the highest form of centralization of the heat supply and the most efficient method of using the fuel resources in the country for heat and power supply. As a result of significant social, economic and ecologic advantages, district heating has been defined as one of the basic areas of development of power engineering in the USSR since the first years of the organization of the Soviet Government.

## 2. Modern Level of District Heating in the USSR

The history of Soviet district heating has been continuously connected with the general development of Soviet power engineering.

The orientation of Soviet power engineering to the combined production of electric power and heat was provided for in the State Plan for Electrification of Russia — the famous GOELRO Plan — developed by the initiative of V. I. Lenin by a group of scientists and engineers directed by G. M. Krzhizhanovskiy and approved by the Eighth All-Russian Congress of Soviets in December 1920. This idea, which completely justified itself by the experience in the development of Soviet district heating, has been realized broadly in the cities and industrial areas of our country.

For the successful development of district heating, the development and practical implementation of plans that have been coordinated with respect to time and scale for the construction and introduction into operation of heat sources, thermal networks and heat-using subscriber units are necessary. The conditions of the planned economy of our country theoretically promote the solution to this problem.

The birth date of Soviet district heating is considered to be the 25th of November 1924. The first general-purpose heat duct constructed by the plan and in the direction of the pioneers of Soviet district heating L. L. Ginter and V. V. Dmitriyev, was put into operation in Leningrad on that day.

After Leningrad, the district heating of Moscow was started. The initiator of the district heating of Moscow was the All-Union Heat Engineering Institute. The first general-purpose heat line was laid in Moscow in 1928 from the experimental heat and electric power plant of the VTI Institute to a number of industrial enterprises. The startup of the first district heating units in Leningrad and Moscow was a stimulus for the development of district heating in many other cities of the USSR.

In Fig 4 data are presented which characterize the development of district heating from the time of its birth (1924) to the present time (1976), and the future prospects are presented to the end of the Tenth Five-Year Plan (1980).

In 1976 the electric power of the district heating turbines installed at the electric power plants of the USSR was 63 million kilowatts, that is, about 1/3 of the power of all of the thermal electric power plants of the country. The combined generation of electric power at the heat and electric power plants was about 200 billion kilowatt-hours, that is, more than 20% of the total output of all of the thermal electric power plants of the country. The annual heat output from the heat and electric power plants was 4 billion gigajoules (950 million gigacalories) which satisfied approximately 40% of the total use of low and medium potential heat in the country. Along with the district heating, centralized heat supply from industrial and district boiler plants and also from the exhaust heat units was developed in the USSR.

The output of heat from all of these units in 1976 amounted to about 3.6 billion gigajoules 850 million gigacalories) which satisfied 35% of the total heat consumption of the country. In all, the centralized sources produced 7.6 billion gigajoules (1800 million gigacalories) of heat in 1976, which satisfied 75% of the heat consumption of the country.

The expected level of development of district heating and centralized heat supply by the end of the Tenth Five-Year Plan (1980) has been defined according to the expert evaluations of the author as follows: electric power from the district heat turbines 77 million kilowatts; annual output of electric power by the district heating turbines 400 billion kilowatt-hours, including 270 billion kilowatt-hours by the combined method. The heat output from the heat and electric power plants is 4.8 billion gigajoules (1.15 billion gigacalories), and the heat output from the other units of the centralized heat supply amounted to 4.5 billion gigajoules (1.07 billion gigacalories).

The total heat output of all of the centralized heating units amounted to 9.3 billion gigajoules (2.2 billion gigacalories) which will satisfy about 80% of the needs of the country for low and medium potential heat.

Both with respect to scale of development of district heating and with respect to the scale of development of the centralized heat supply the USSR has persistently held first place in the world.

3. Improvement of the Power Engineering Base of District Heating

Soviet district heating is based on the district heat and electric power plants, from which the heat is distributed both to the industrial enterprises and to nearby cities.

For supplying heat to the heating and air conditioning units and for supplying hot water to the residential and public buildings and industrial enterprises, primarily water is used as the heat-transfer agent. At the present time the proportion of water as the heat-transfer agent is 48% in the total annual heat output from the heat and electric power plants. The Soviet Union has the largest water network in the world. The application of water as the heat-transfer agent permits the use of low-pressure spent steam from the district heating turbines for the heat supply, as a result of which the specific combined electric output per unit output heat.

For example, for initial steam parameters at the heat and electric power plants of 13 MPa, 555°C and the application of water as the heat-transfer agent, the average temperature of the heat from the turbine taps when satisfying the domestic heating load is 80°C, and the specific combined output of electric power is 155 kilowatt-hours/gigajoule (640 kilowatt-hours/gigacalorie). When using steam as the heat-transfer agent for these purposes with a pressure at the plant manifold, for example, of 0.8 MPa, the specific combined output is 80 kilowatt-hour/gigajoule (325 kilowatt-hour/gigacalorie), that is, approximately half that for water.

The thermal economicalness of the heat and electric power plants improves with an increase in the initial steam parameters, a decrease in the steam pressure in the turbine taps, the application of multistage heating of the network water, an increase in the number of hours of use of the thermal power of the taps, restriction of the proportion of the electric power output by the condensation method.

The improvement of the economic indexes of district heating is promoted by enlargement of the heat and electric power plants and increasing the unit power of the boiler plants and turbine units, modular composition of the equipment and also the application of cheap water heating boilers and low-pressure steam boilers for covering the short-term peaks of the seasonal and the technological thermal load and redundancy of the heat supply.

The use of high-power water heating boilers also in a number of cases gives a gain in priority of the capital investments, permitting with minimum initial expenditures the centralization of the heat supply in districts where the introduction of heat and electric power plants into operation lags behind the introduction of the heat users. After the introduction of the heat and electric power plants into operation, these water-heating boilers are used to cover the peak part of the thermal load and for heat supply redundancy.

In order to reduce the time required to build the heat and electric power plants, for significant reduction of their initial cost and labor expenditures on their construction the industrialization of the installation of the heat and electric power plants has great significance. In the USSR plans have been developed for series heat and electric power plants with increased plant prefabrication for various types of fuel in which provision is made for construction of them by assembling standardized structural-process sections with various types of turbines and like boilers. The construction of such heat and electric power plants basically reduces to the installation of standard unitized large-module units at the construction site.

At the present time highly economical large-power district heating turbines are being produced in the USSR for high (13 MPa) and transcritical (24 MPa) steam parameters: type T with heating tap; unit power from 50 to 250 MWatts (T-50/60-130, T-105/120-130, T-250/300-240); type PT with industrial heating taps, a unit power from 60 to 135 MWatts (PT-60/75-130/13, PT-50/60-130/7, PT-80/100-130/13, PT-135/165-130/1), type R with counterpressure and a unit power from 40 to 100 MWatts (R-40-130/31, R-50-130/13, R-100-130/15).

In the near future the production of new turbines will begin operating on initial parameters of 13 MPa with a heating tap with increased power of 175 and 180 MWatts, T-175/210-130 and T-180/215-130.

The USSR has significant reserves of natural power resources, including organic fuel. However, as a result of the geographic noncoincidence of the areas where the basic energy resources are located (the eastern parts of the country) with the basic areas that use electric and thermal power (the European part of the USSR), there is a shortage of organic fuel in the European part of the USSR.

In order to improve the fuel and energy balance of the country there is a plan to have the European part of the USSR and also other parts of the country completely removed from the organic fuel bases to use nuclear fuel as the primary power resource.

It is natural that the use of nuclear fuel at the heat and electric power plants for combined generation of electric power and heat is energy-wise more efficient than with the separate method of generating electric power at the condensation electric power plants and heat in the boiler plants.

The basic advantages of the nuclear heat and electric power plants by comparison with those that operate on organic fuel are as follows:

a) Relative independence of the location of the nuclear plant with respect to the location of the fuel base as a result of the insignificant mass consumption of nuclear fuel and the small expenditures on hauling and storing the fuel connected with this.

b) The possibility of freer choice of sites for building the nuclear heat and electric power plants for ecologic regions, as a result of the absence of harmful discharge with the flue gases that pollute the environment.

The experience in operating and maintaining existing nuclear power plants indicates that the discharge of waste water polluted with radioactive materials has been completely excluded. Radioactive gases and aerosols are scrubbed before removal through the ventilation pipes. Many years of observations of the concentration of radioactive materials in the air, soil and bodies of water near operating nuclear power plants indicate the absence of harmful influence of the nuclear power plant on the environment.

The first nuclear heat and electric power plant in the USSR was put into operation in the village of Bilibino (Siberia) in 1973. This plant with a planned electric power of 48 megawatts is made up of four modules with an electric power of 12 megawatts each. The modules are executed from single-loop channel-type water-graphite reactors and district heating turbines with the T-12-60 heating tap.

At the present time the USSR is conducting broad planning and research experiments in the creation of powerful district nuclear heat and electric power plants.

As the research has demonstrated, with a large calculated thermal load on the order of 1750 megawatts (1500 gigacalories/hour) and more, the nuclear heat and electric power plants are able to compete economically with the heat and electric power plants operated on organic fuel.

Further progress in the heat and electric power plants operating on organic fuel will take place primarily in the direction of increasing operating reliability and improving the structure of the equipment.

The introduction of more and more capacity at the heat and electric power plants with high and transcritical initial parameters, along with improving the loading of the turbine taps will lead to a further increase in the specific combined generation of electric power per unit heat output from the turbine taps and also an increase in the proportion of the combined generation of electric power at the heat and electric power plants.

With an expected heat output from the general-purpose stations of 3.8 billion gigajoules (0.9 billion gigacalories) in 1980, the combined generation of electric power at the heat and electric power plants will be about 250 billion kilowatt-hours, and the fuel savings as a result of the electric output of the heat and electric power plants will exceed 35 million tons.

4. Improvement of the Heat Supply System

An important component part of district heating is the centralized heat supply system, the goal of which is the transformation of the heat-transfer agent from the heat supply source to the regions of consumption and distribution of it with respect to the heat users.

In connection with the development of industry and intense residential-communal construction in individual parts of the country large territorial formations are arising with high concentration of the thermal load interconnected by intraterritorial engineering structures, including the thermal networks.

This gives rise to the necessity for converting in the near future in such regions from the local heat supply of individual enterprises or individual municipal rayons to the all-around heat supply of large territorial formations of so-called agglomerations.

This type of transformation must be made under dynamic conditions, that is, under the conditions of development of the system, with the use of previously constructed and operating heat supply units, as the elements of the general agglomeration centralized heat supply system.

In connection with the increased requirements on the quality of planning and the purity of the air basin of the cities and also the change in fuel structure of power engineering in the direction of increasing the proportion of solid fuel and atomic fuel, many powerful heat and electric power plants, primarily for supplying heat in large cities and industrial-municipal agglomerations will be located at a significant distance from the heat consumption areas, frequently beyond the city limits, which requires the construction of transit heat ducts of significant length and a corresponding increase in the initial expenditures on the heating networks.

One of the basic means of lowering the initial expenditures on the construction of the heating networks and the operating expenditures with respect to the transportation of heat is an increase in the calculated water temperature in the feed line from the level of 150°C mastered and widely used at the present time to 170-190°C. This solution is economically justified in the USSR not only for the regions of Siberia, the Urals and Kazakhstan, with comparatively low closing expenditures on fuel, but also for the European parts of the USSR with high closing expenditures on fuel.

Reliability of the heat supply has exceptionally important significance.

In order to increase the reliability of the heat supply it is expedient to divide the long main water networks into sections 2 to 3 km long. As a result of this, the losses of water from the heating network from emergencies decrease, for the emergency section of the network is located on both sides, using sectioning slide valves. This facilitates the elimination of an emergency and accelerates the inclusion of the network in operation after an emergency.

In the modern heat supply systems of large cities, the heat-transfer agent -- the network water from each powerful heat and electric power plant -- usually is fed to the heat supply areas through several main lines. It is expedient to join these lines by blocking communications (cross connections).

Significant reserves in the operating district heating systems can be used with proper regulation and adjustment of their operating conditions.

The actual specific combined generation of electric power, the operating expenditures with respect to the transportation of heat and the quality of the heat supplies as a whole depend essentially on the completeness of using the heat-transfer agent in the subscriber units. The improvement of the quality of the heat supply and improvement of the use of the heat-transfer agent in the subscriber units is connected with improving the automation of local regulation.

In order to equalize the annual thermal load chart, it is of interest to use the exhaust heat of the heat and electric power plants to heat the hothouses and greenhouses and also to generate cold in the air conditioning units at the industrial enterprises and public buildings. In the near future there will be significant increase in cold load of the air conditioning units first of all in the regions with warm climates (the Central Asian and Trans Caucasus Republics).

The reduction of the initial expenditures on building thermal networks, the acceleration of the construction and improvement of the reliability and service life of the heating lines constitute an urgent problem. Both in the USSR and abroad, the progress in this area is proceeding along the path of industrialization of the structural designs by plant manufacture of the heat line modules and mechanization of their construction.

In the USSR significant scientific research and design work is being done in the field of improving underground heating lines.

In Leningrad, Moscow and other cities, the structural design of the heating lines in monolithic shells of reinforced foam concrete applied to the lines under plant conditions has become widespread in practice for all pipe diameters.

An industrial design has been developed for the heating lines in monolithic shells of cellular phenol foam plastic.

The structural designs have been developed for channelless heating lines with monolithic shells based on asphalt binder (asphalt perlite, asphalt claydite, and so on) for lines up to 400 mm in diameter.

A number of sections of heating lines using asphalt insulation are in experimental industrial operation both as poured insulation and for spreading of the pipes with a hot molten mass.

The method of protecting underground pipes from outside corrosion by induction enamelling of their outside surface has been developed and checked out under laboratory conditions and in the experimental sections.

6. Ecologic Effect of District Heating

The centralization of the heat supply and especially district heating have significant influence on improving the sanitary state of the environment. As a result of the fuel savings obtained in 1976 from combined generation at the heat and electric power plants of the country in the amount of 36 million tons of provisional fuel, the amount of annual discharge of gaseous products of combustion has been reduced by 130 million tons.

The significant additional effect with respect to decreasing the environmental pollution of populated areas is achieved with district heating as a result of constructing large heat and electric power plants outside the city limits.

The creation of large sources of combined production of thermal and electric power has made it possible to organize effective trapping of the products of combustion of the fuel and the drainless systems of preparing makeup water, which in small and even large boiler plants operating only for heat supply, in practice is not realizable both with respect to the volume of operations and with respect to the capital investments required for this purpose.

The development of district heating in the existing old cities will permit annual closure of more than a thousand boiler plants which will significantly improve the sanitary conditions of these cities.

The water preparation in small boiler plants is usually realized by the sodium-cationization system in which highly mineralized water is discharged into the drains. Under district heating conditions, when generating the heat at the powerful heat and electric power plants, large devices can be built for drainless preparation of makeup water, for example, multistage evaporators.

The ecologic harmfulness of the decentralized heat supply becomes deeper as a result of low height of the smokestacks, which leads to low scattering of the discharge and high concentration of it in the ground layer. At the modern powerful heat and electric power plants, significantly more effective ash trapping devices have been installed by comparison with the boiler plants, and high smokestacks are being built. All of this will significantly improve the cleanness of the air basin.

The construction of the heat of the heat and electric power plants using nuclear fuel planned in the near future will simplify the solution of the ecologic problem as a result of the absence of discharge of powerful gases into the atmosphere.

6. Reduction of Expenditures of Labor in Power Management

In the case of district heating, there is significant reduction of the expenditures of labor on operating and maintaining the thermal power systems and installations of the industrial rayons and cities by comparison with separate heat supply, which has important significance under the conditions of the USSR with 100% employment and the absence of the labor reserves. District heating makes it possible to decrease the number of personnel servicing the power systems of the cities by comparison with heat supply from local sources of heat by 5 to 7 times and by comparison with the heat supply from large district boiler plants by 30 to 35%.

7. Creation of the District Heating Science

The successful realization of Soviet district heating on all levels of its development is promoted by scientific studies closely connected with practice. In this research, along with the scientific workers there is active participation by engineering and technical personnel designing, building, operating and adjusting the district heating systems and installations. Soviet power engineers have created a science which provides for the proper solution of all of the basic technical and technical-economic problems of district heating and the development of the basic paths of its future development.

Soviet scientists have compiled textbooks and teaching aids on the basis of which systematic training is offered at the institutions of higher learning and the technical high schools for engineering and technical personnel for district heating and the retraining of the personnel already employed.

Summary

One of the basic areas of power engineering in the USSR is district heating, that is, the centralized heat supply based on combined generation of electric and thermal power.

District heating results in large savings of fuel, it significantly improves the sanitary state of the environment as a result of decreasing the amount of discharge of combustion products, it lowers the expenditures of labor on the operation and maintenance of the heating systems and installations of the cities and industrial rayons.

Soviet district heating is based on powerful heat and electric power plants from which heat is distributed to the industrial enterprises and nearby cities and populated areas.

In Soviet district heating water is widely used as the heat-transfer agent. This promotes the obtaining of high specific combined generation of electric power and increased specific savings of fuel per unit heat from the turbine taps.

The improvement of the economic indexes of the heat and electric power plants is promoted by an increase in the initial steam parameters, a reduction in the steam pressure in the turbine taps, an increase in unit power of the boiler plants and turbine units, modular composition of the equipment, the application of cheap water heating and steam boilers for covering the short-term seasonal and process thermal loading peaks and the industrialization of the construction of the heating networks.

In 1976, on the basis of the combined generation of electric and thermal power at the general-purpose heat and electric power plants, 30 million tons of provisional fuel have been saved. This amounts to about 11% of the total fuel consumption for the generation of electric power in the country.

As a result of the development of district heating and the overall progress in power engineering, with respect to level of thermal economicalness of the electric power production, the USSR has taken first place among the industrially developed countries of the world in recent years.

In 1977 the average specific consumption of provisional fuel (net) for the generation of electric power was 334 g/kilowatt-hour, which corresponds to an efficiency (net) of 0.37.

The development of district heating in the USSR is promoted by improvement of the heat supply systems and industrialization of the construction of the heating lines.

In the USSR industrial designs have been developed for the heating lines in monolithic shells made of reinforced foam concrete, phenol foam plastics, asphalt perlite and other materials permitting a significant reduction in the material and labor expenditures on building the heating networks.

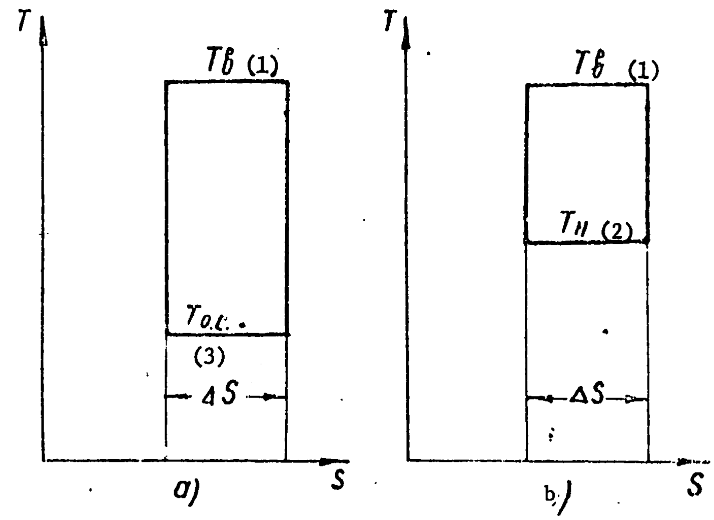



Figure 1. Ideal cycles for the thermal electric power plants in a T-S diagram:
a -- condensation; b -- district heating.

Key:
1. $T_b$ -- average temperature of feeding heat to the cycle
2. $T_H$ -- average temperature of removing heat from the district heating cycle
3. $T_{o.c.}$ -- ambient temperature

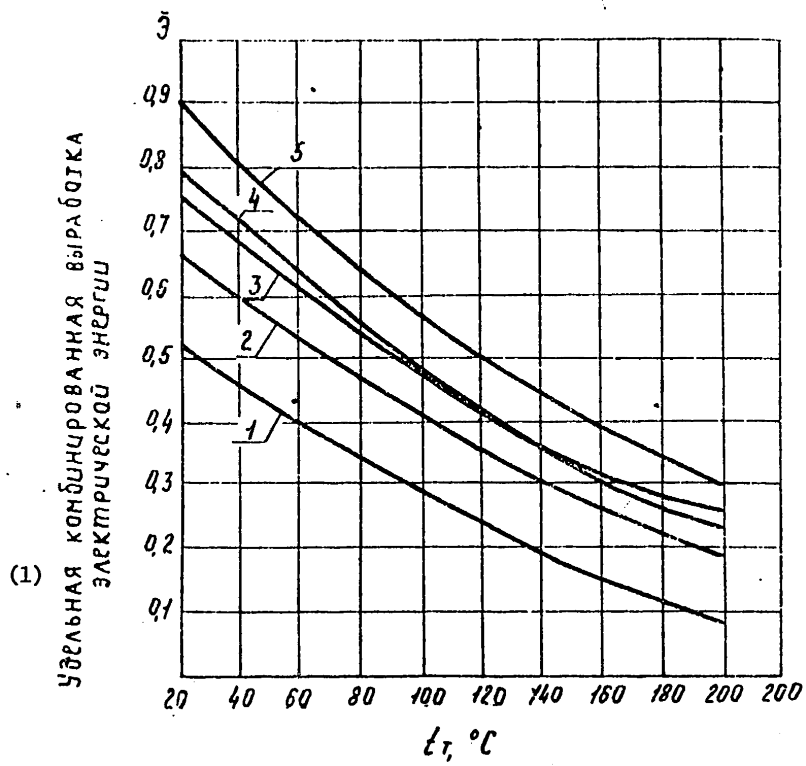
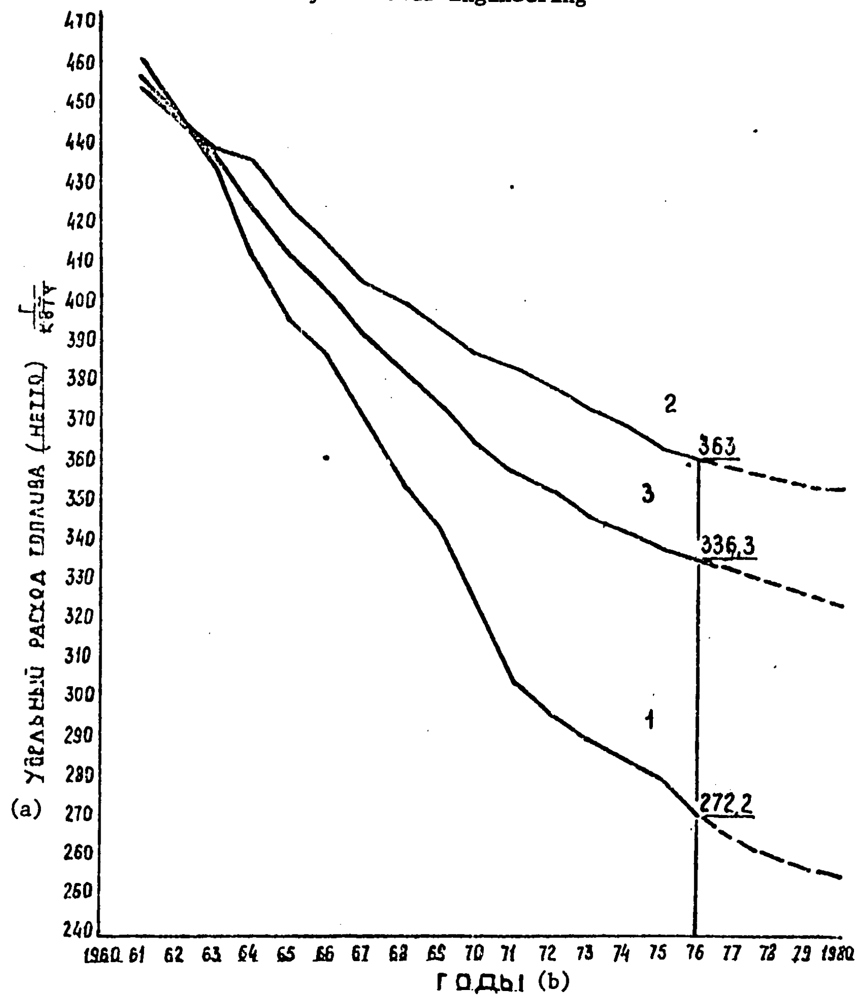



Figure 2. Specific combined generation of electric power based on heat consumption

Key:

1. Specific combined generation of electric power

Specific fuel consumption (net) at the eleccric power plants of the USSR Ministry of Power Engineering




ПУНКТИР---ОРИЕНТИРОВОЧНО (c)

Figure 3

Key:

a. Specific fuel consumption (net), g/kilowatt-hour
b. Years
1. Average with respect to all heat and electric power plants
2. Average with respect to all condensation electric power plants
3. Average with respect to all thermal electric power plants
c. Dotted line --- approximate

Development of district heating in the USSR

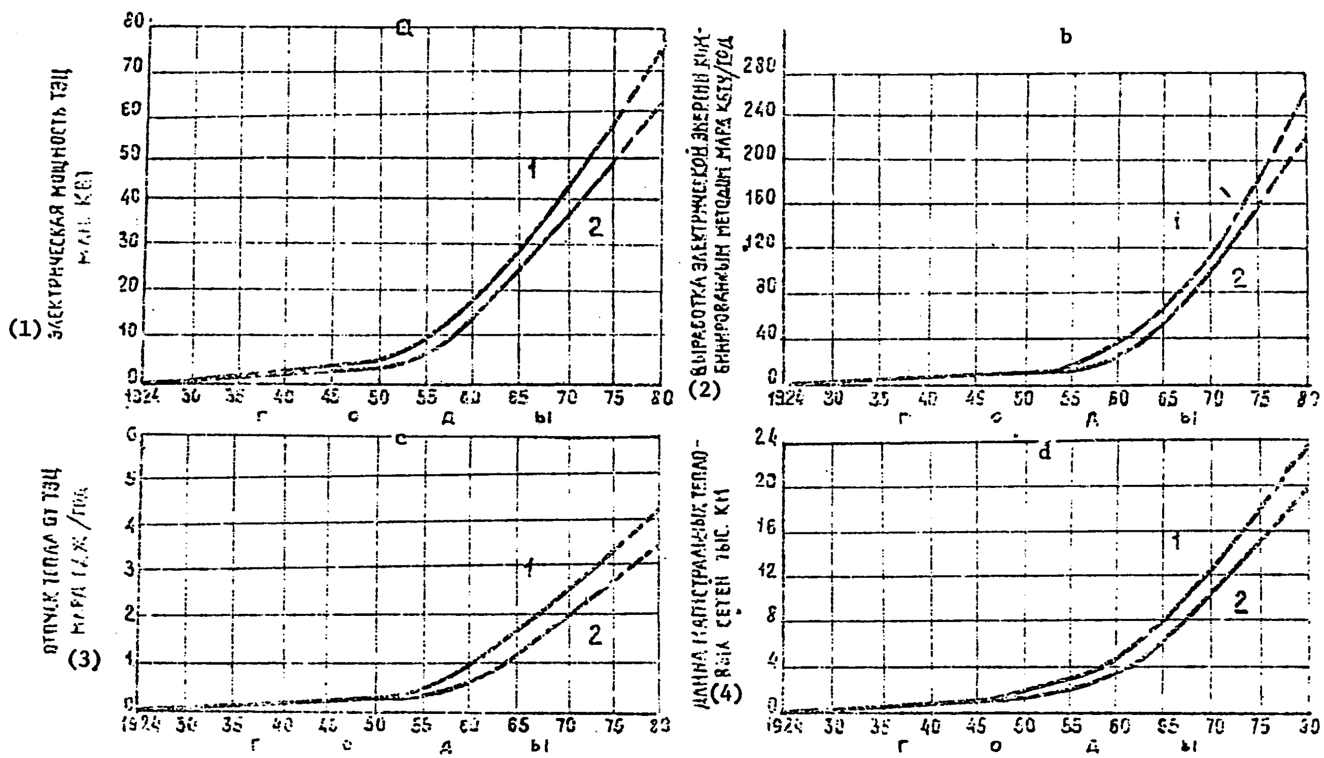



Figure 4

1 -- total; 2 -- general-purpose stations; dotted line -- approximate data.
a -- electric power of the heat and electric power plants; b -- generation of electric power by the combined method; c -- heat output; d -- length of the heating networks
Key: 1 -- Electric power of the heat and electric power plants, millions of kilowatts; 2. generation of electric power by combined method, billions of kilowatt-hours/year; 3. heat released from the heat and electric power plants, billions of gigajoules/year; 4. length of main heating networks, thousand km.





10845
CSO: 8144/0358

FUELS AND RELATED EQUIPMENT

UDC 550.4:553.982(571.1)

# GEOCHEMICAL INDICES OF THE COMPOSITION OF PETROLEUMS IN THE OB' REGION

Moscow GEOLOGIYA NEFTI I GAZA in Russian No 7, Jul 79 pp 11-14

[Article by L. S. Ozeranskaya, Central Laboratory Glavtyumen'geologiya, M. Ya. Rudkevich and L. Ye. Svintitskikh, Tyumen' Research Institute, submitted for publication 31 July 1978]

[Text] The study of the physicochemical properties of petroleums in the Middle Ob' region made it possible to ascertain the regularities of their spatial change and describe the mechanism of formation of present-day concentrations of hydrocarbons. In our opinion, it is possible to discriminate at least two stages in petroleum and gas accumulation. In the first stage the traps were filled with petroleum in the process of migration and differentiation of the petroleum-gas system. For the most part it ended on the boundary between the Mesozoic and Cenozoic eras. In the second stage new products of gas condensate and petroleum-gas condensate mixtures entered the deposit. The source for the gas and condensate was extensive depressions situated to the north of the arched uplifts of the Middle Ob' region.

The second stage can be related to the neotectonic uplifting of the northern regions of the West Siberian Platform and the energetic release of gas from a water-dissolved state to a free state. This resulted in the formation of gas caps over petroleum pools in the Neocomian strata of the Surgutskiy and Nizhnevartovskiy regions (Fedorovskoye, Samotlorskoye, Lyantorskoye, Vostokinskoye, Severo-Minchimkinskoye and other deposits, Fig. 1).

Such a mechanism of the formation of petroleum and petroleum-gas deposits in the Middle Ob' region was described earlier taking into account paleotectonic reconstructions [5]. In this article we give its geochemical substantiation. At the Central Laboratory of the Glavtyumen'geologiya Trust the capillary gas-fluid chromatography method was used in investigation of the individual hydrocarbon composition of the benzine fractions of petroleums (temperature 130°C, more than 300 samples) from the Lower Cretaceous and Jurassic deposits of the Middle Ob' region.

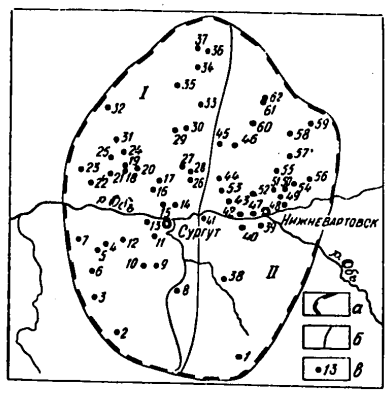



Fig. 1. Overall map of investigated region. a) schematic contours of the Middle Ob' petroleum- and gas-bearing region; b) boundary: Surgutskiy (I) and Nizhnevartovskiy (II) regions; c) petroleum deposits: 1) Larlomkinskoye, 2) Novokeumskoye, 3) Verkhnesalymskoye, 4) Salymskoye, 5) Malo-Salymskoye, 6) Zapadno-Salymskoye, 7) Verkhneshapshinskoye, 8) Multanovskoye, 9) Yuzhno-Balykskoye, 10) Malo-Balykskoye, 11) Mamontovskoye, 12) Pravdinskoye, 13) Ust'-Balykskoye, 14) Vostochno-Surgutskoye, 15) Yuzhno-Surgutskoye, 16) Bystrinskoye, 17) Vynginskoye, 18) Lyantorskoye, 19) Vostokinskoye, 20) Severo-Minchimkinskoye, 21) Studenoye, 22) Gorshkovskoye, 23) Tumannoye, 24) Alekhinskoye, 25) Ay-Pimskoye, 26) Fedorovskoye, 27) Vostochno-Mokhovoye, 28) Savuyskoye, 29) Tevlinskoye, 30) Kogolymskoye, 31) Nizhnesortymskoye, 32) Iyul'skoye, 33) Kholmogorskoye, 34) Karamovskoye (Iturskoye), 35) Nyatlongskoye, 36) Pul'puyakhskoye, 37) Kollektivnoye, 38) Malo-Yuganskoye, 39) Yermakovskoye, 40) Orekhovskoye, 41) Pokamasovskoye, 42) Severo-Pokurskoye, 43) Ur'yevskoye, 44) Pokachevskoye, 45) Vat'yeganskoye, 46) Povkhovskoye (Sredne-Vat'yeganskoye), 47) Vatinskoye, 48) Samotlorskoye, 49) Chernogorskoye, 50) Malo-Chernogorskoye, 51) Bol'shoye Chernogorskoye, 52) Aganskoye, 53) Potochnoye, 54) Tyumenskoye, 55) Van'yeganskoye, 56) Novomolodezhnoye, 57) Var'yeganskoye, 58) Severo-Var'yeganskoye, 59) Tagrinskoye, 60) Bol'shekotukhtinskoye, 61) Yuzhno-Vyngapurskoye, 62) Vyngapurskoye

In the Middle Ob' region the petroleum pools are associated with rocks of a broad stratigraphic range -- from the top of the Barremian stage to the horizons of the undissected Lower-Middle Jurassic terrigenous stratum, which corresponds to a depth range 1600-3100 m.

The following groups of productive strata are defined: regional permeable complexes -- $A_1$-$A_{12}$ (Upper Hauterivian-Barremian), $B_1$-$B_{12}$ (Upper Valanginian-Hauterivian), Yu1 (Upper Jurassic); zonal complex, that is, lenticular sandy strata within an essentially clayey stratum -- $B_{16}$-$B_{22}$ (Berriasian-Lower Valanginian; nonpersistence of sandy stratum in strike at the top of the Lower-Middle Jurassic regional permeable complex -- $Yu_2$. In different zones of the Surgutskiy and Nizhnevartovskiy regions the principal petroleum deposits are concentrated in different complexes in dependence on the structural and lithological characteristics of these zones [2, 6].

In general, for the Middle Ob' region, with an increase in the depth of the pools there is a tendency to a decrease in the petroleums, content of tars, asphaltenes and sulfur and an increase in the quantity of paraffins; in the composition of the light fractions there is an increase in the fraction of normal structures among the alkanes, hexamethylenes among cyclanes, the quantity of aromatic hydrocarbons [1].

The paired correlation coefficients are 0.3, 0.38, 0.38 respectively. The number of observations was 129; the correlation coefficients are different from zero with a reliability 0.95 with $r \geqslant |0.17|$.

With an increase in the depth of the petroleum the molecular mass of asphaltenes decreases from 2700 in strata of group A to 1500 in the horizon $BS_{10}$ (Surgutskiy region), whereas the fraction of hydrocarbon in the aromatic structures of asphaltenes increases from 0.53 to 0.66 respectively. For the Nizhnevartovskiy region the mean value of this parameter is 0.52-0.53; its variations in the section are not very great [3].

The change in the composition and properties of petroleums in the vertical section in general corresponds to the general patterns established by A. F. Dobryanskiy, et al. [4]. At the same time, some geochemical parameters of the individual composition of hydrocarbons of light fractions of petroleums from strata and layers of the same age vary with depth in such a way that these variations cannot be attributed only to the thermocatalytic processes transpiring with the plunging of sedimentary strata. For example, the petroleums from the strata of group A in the Surgutskiy arch in the pools at greater depths are characterized by lesser values of the ratio of alkanes to cyclanes ($\sum$ alkanes/ $\sum$ cyclanes). At the same time it is possible to discriminate a sharply isolated group of petroleum and gas deposits with an anomalously low value of the indicated ratio independently of depth. These are pools with thick and broad gas caps of the Fedorovskoye, Severo-Minchimkinskoye, Vostokinskoye and Lyantorskoye deposits (Fig. 2, a).

An appreciable decrease in the ratio $\sum$ alkanes/ $\sum$ cyclanes is also noted for the gas and petroleum pools in strata of group A in the Nizhnevartovskiy region (Samotlorskoye, Aganskoye, Vatinskoye, Severo-Pokurskoye deposits), for which the deposit in stratum $AB_{1-2}$ is common (see Fig. 2,b). However, in contrast to the Surgutskiy region the value of the mentioned ratio here is appreciably greater, which agrees well with the lesser fraction of gas in the gas and petroleum deposits of the Nizhnevartovskiy region. In complete accordance with the noted peculiarities in the change in the $\sum$ alkanes/ $\sum$ cyclanes values is also the ratio $\sum$ n-alkanes/ $\sum$ isoalkanes (see Fig. 2,c).

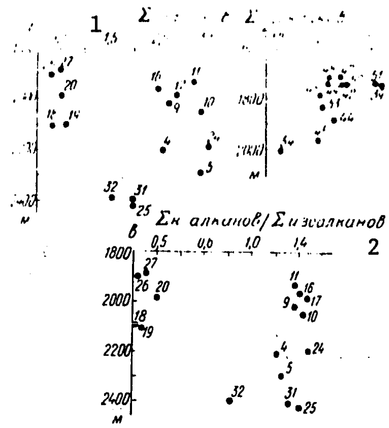


Fig. 2. Change in ratios $\sum$alkanes/ $\sum$cyclanes and $\sum$n-alkanes/ $\sum$iso-alkanes of light fractions of petroleums with depth in strata of group A of deposits of same age in the Surgutskiy (a,c) and Nizhnevartovskiy (b) regions. For names of deposits see Fig. 1.

KEY:

1. $\sum$alkanes/ $\sum$cyclanes
2. $\sum$n-alkanes/ $\sum$ isoalkanes

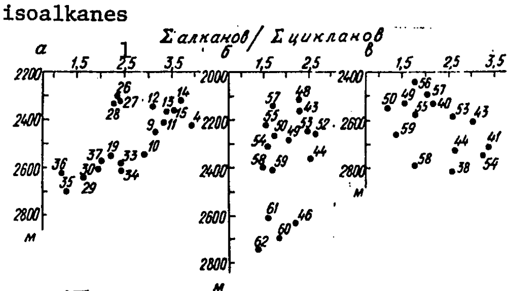


Fig. 3. Change in ratio of $\sum$ alkanes/ $\sum$ cyclanes of light fractions of petroleums with depth in deposits of same age in strata of group B in Surgutskiy (a) and Nizhnevartovskiy (b, c -- $Yu_1$ stratum) regions. For names of deposits see Fig. 1.

KEY:

1. $\sum$ alkanes/ $\sum$ cyclanes

The group of gas-petroleum deposits with a sharply reduced value of this coefficient stands out very clearly. For example, for strata in group A of the Fedorovskoye, Vostochno-Mokhovoye, Severo-Minchimkinskoye, Vostokinskoye and Lyantorskoye deposits the ratio $\sum$n-alkanes/ $\sum$ isoalkanes is 0.02-0.2 in the depth range 1900-2100 m; for most deposits in strata of the same age, situated at identical depths, but deprived of considerable gas caps (Bystrinskoye, Vynginskoye, Alekhinskoye and other deposits) it varies in the range 0.8-1.5.

In strata of group B in the Surgutskiy region there is also a decrease in the ratio $\sum$ alkanes/ $\sum$ cyclanes with an increase in depth (Fig. 3,a). Here there are gas caps in the deposits of horizon $BS_{10}$ in the Fedorovskoye, Vostochno-Mokhovoye and Savuyskoye deposits.

In the Nizhnevartovskiy region in the petroleum strata of group B the ratio $\sum$ alkanes/ $\sum$ cyclanes does not have a clear correlation with depth (see Fig. 3,b). It is interesting to note that for the stratum $Yu_1$ in this same region there is characteristically an increase in the ratio $\sum$ alkanes/ $\sum$ cyclanes with an increase in depth of the petroleum deposits (see Fig. 3,c).

The ratio $\sum$ n-alkanes/$\sum$ isoalkanes in the light fraction of petroleums in the stratum of group B in Surgutskiy region decreases from 1.55 to 1 with an increase in the depth of the deposits from 2300 to 2700 m. For the Nizhnevartovskiy region this value increases insignificantly from 1 at depths of 2000-2200 m to 1.5 in the depth range 2600-2700 m. In the petroleums of stratum $BS_{10}$ in the Surgutskiy region the molecular mass of asphaltenes changes little with an increase in the depth of the deposits, but the fraction of aromatic structures increases from 0.55 to 0.66, whereas the fraction of naphthene rings decreases from 0.2 to 0.07.

The behavior of individual hydrocarbons of light fractions of petroleums in the Surgutskiy region and in part in the strata of group A in the Nizhnevartovskiy region, noted above, can be explained in the following way.

The petroleum deposits in all the horizons of the Jurassic and Neocomian were initially formed in the process of successive passage of the sedimentary strata through geomorphological cycles, the transformation of organic matter, the migration and accumulation of hydrocarbons in long-developing cosedimentation traps. In the Cenozoic era and especially in the neotectonic stage a gas-condensate mixture entered the already forming petroleum deposits. As is well known, petroleum alkanes have the best solubility in rich condensate gases. Therefore, moving through the rise in the strata, the gas condensate mixture must extract the alkane components from the petroleum deposits; these, together with the petroleum, migrate from the buried traps to more uplifted traps. As a result, there is an enrichment of the petroleums with light alkanes in hypsometrically higher deposits. Later, after the maximum gas saturation of petroleum deposits associated with traps at the tops of arches this gas is released in the form of caps. The formation of the latter evidently occurred relatively rapidly due to the jumplike neotectonic uplift of the traps. The considerable "accumulated" mass of alkanes from the lower petroleum part of the deposit escapes with the released free gas. As a result, the fraction of alkanes in the light fraction of petroleums in the petroleum and gas deposit is sharply reduced. The greater the relative quantity of gas in it, the lesser is the quantity of alkane components remaining in the petroleum.

If a gas cap is not formed, the petroleum nevertheless becomes highly gas saturated. In such a deposit the value of the ratio $\sum$ alkanes/$\sum$ cyclanes is increased. Finally, in a case when the gas-condensate mixture does not enter the petroleum deposit it retains the relationship between the groups of hydrocarbons forming in the process of initial formation. For example, the petroleum deposits in stratum $Yu_1$ and in the Lower Neocomian horizons of the Nizhnevartovskiy region are not diluted by a gas condensate mixture. Therefore, they are characterized by an increase in the ratios $\sum$ alkanes/$\sum$ cyclanes, $\sum$ n-alkanes/$\sum$ isoalkanes with depth. This tendency reflects the direction of the process of transformation of organic matter during catagenesis. Secondary gas saturation did not exert an appreciable influence on the behavior of the heavy fractions of petroleums (tar, asphaltenes) as a result of their poor solubility in condensate gases.

Our investigations have practical importance in the search for zones of petroleum and gas accumulation in the northern regions of the West Siberian Province.

BIBLIOGRAPHY

1. Vovk, M. A., Ozeranskaya, L. S., Perevozchikova, A. F., "On the Problem of Classification of Petroleums and Condensates in the Deposits of Tyumenskaya Oblast on the Basis of the Composition of Light Hydrocarbons," TRUDY IN-TA GEOLOGII I GEOFIZIKI (Transactions of the Institute of Geology and Geophysics), Novosibirsk, No 334, pp 88-94, 1977.

2. Kontorovich, A. E., Nesterov, I. I., Salmanov, F. K., et al., GEOLOGIYA NEFTI I GAZA ZAPADNOY SIBIRI (Geology of Petroleum and Gas in Western Siberia), Moscow, Nedra, 1975.

3. Magaril, R. Z., Svintitskikh, L. Ye., "Physicochemical Properties of Petroleum Asphaltenes in Western Siberia," IZV. VUZov, NEFT' I GAZ (News of Institutes of Higher Education, Petroleum and Gas), No 12, pp 57-60, 1974.

4. Andreyev, P. F., Bogomolov, A. I., Dobryanskiy, A. F., Kartsev, A. A., PREVRASHCHENIYA NEFTI V PRIRODE (Petroleum Transformations in Nature), Leningrad, Gostoptekhizdat, 1958.

5. Rudkevich, M. Ya., PALEOTEKTONICHESKIYE KRITERII NEFTEGAZONOSNOSTI (Paleotectonic Criteria for the Presence of Petroleum and Gas), Moscow, Nedra, 1974.

6. Rudkevich, M. Ya., Glukhoyedov, Yu. M., Maksimov, Ye. M., "Tectonic Development and Petroleum Geology Regionalization of the West Siberian Province," TRUDY ZapSibNIGNI (Transactions of the West Siberian Petroleum Scientific Research Institute for Geological Survey), Sverdlovsk, No 92, pp 1-172, 1976.


[37-5303]

5303
CSO: 1822



APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200040036-6

FUELS AND RELATED EQUIPMENT

UDC 553.981.6(571.1)

# CHARACTERISTICS OF CONDENSATES IN WESTERN SIBERIA

Moscow GEOLOGIYA NEFTI I GAZA in Russian No 7, Jul 79 pp 15-18

[Article by V. A. Gushchin and Ye. G. Gushchina, West Siberian Petroleum Scientific Research Institute for Geological Survey, submitted for publication 10 October 1978]

[Text] Preparations for the commercial exploitation of the condensate resources in Western Siberia were favored by a substantial increase in the volume of information on the characteristics of gas condensate systems. In this article we present the results of a statistical analysis of the physicochemical parameters of fluids in gas condensate deposits.

At first glance the available data demonstrates the broad diversity of their indices. However, the scatter of values of the principal parameters observed in the analyses of the most studied deposits is comparable with the range of fluctuations of these characteristics, which is evidence of the need for employing the methods of statistical analysis in any investigation of the patterns of change in the properties of the condensates. In the study use was made of the results of investigation of fluids in gas condensate deposits with a content of $C_5$+higher in stratum gas of more than 0.25%, since with lesser concentrations the methane fractions of the condensate are not separated out in the separators [3].

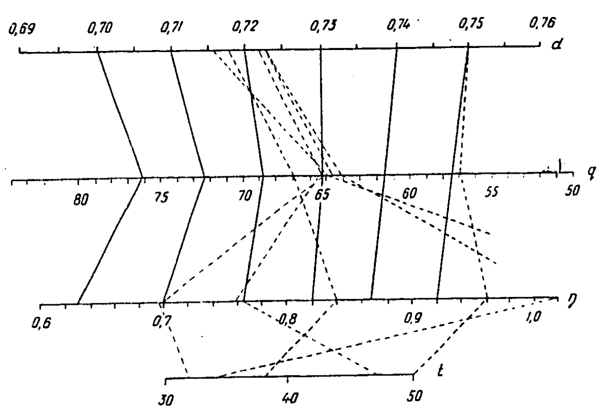
The work was carried out in the following sequence:
1) an analysis of polygons of the distributions of the values of the principal parameters of the stable condensate for the purpose of ascertaining the limiting values and the multidimensional criterion for evaluating the correctness of the analysis;
2) evaluation of the actual materials using the defined criterion and more precise determination of the limiting values;
3) determination and study of the correct analyses of the condensates ("correct," by definition, is the result of a measurement whose error has only a random component [1]).

In this process we solved such problems as the separation of analyses of pure condensates and their mixtures with petroleums, formulation of a method for detecting erroneous results and a comparison of condensates from different regions in Western Siberia.

In the first stage we detected the characteristics most informative from the point of view of the formulated problems. This was achieved by constructing polygons of the distribution of values of the principal parameters and an analysis of their form. The clearest two-mode distribution was obtained in polygons for density, viscosity, yield of fraction boiling away to 150°C, and for the boiling point temperature. The values of these indices, corresponding to the minima of the frequencies of incidence, were adopted as the limits of separation of the condensates and mixtures. The parameters and limits constituted a multidimensional separation criterion whose checking indicated that only a small number of analyses for any of them falls in different regions, that is, can be assigned to both pure condensates and to mixtures. This could result from errors in the analytical process and also due to the nonuniform degree of change in the characteristics of the condensate with the addition of petroleum, which is confirmed by experience in the generalization of the corresponding parameters for the deposits. Therefore, we carried out a refinement of the limiting values by means of discarding such data. The zone separating the petroleum from the condensates was considerably broadened and thereby there was an increase in the reliability of identification of the mixtures. Thus, for the entire territory of Western Siberia we obtained the following limiting values of the principal characteristics of stable condensates:

| | |
|---|---|
| Density (d), g/cm$^3$ | 0.68-0.75 |
| Viscosity at 20°C ($\eta$), centistoke | 0.6-1.0 |
| Yield of fraction up to 150°C (q), % | 52-84 |
| Boiling point (t), °C | 32-50 |

It should be noted that the results of analyses with modern levels of errors fit into these limits.




Nomogram for checking analyses of condensates in Western Siberia

In order to ascertain individual errors in the analyses not exceeding the limiting values it is possible to use the monotonic nature of the physicochemical dependences of the property-property type. For this we constructed a graph-nomogram (see figure). Each of its four horizontal segments is a scale of values of one of the above-mentioned parameters, entering into the multidimensional criterion. The results of determination of these values are plotted on the corresponding scales and the resulting points (belonging to one sample) are joined by straight lines. In the case of monotonic changes in the compositions of these condensates the slopes between the lines and axes change smoothly from one limit to the next. The nomogram also shows lines indicating the relationships among the parameters obtained by approximation of the experimental data for the considered region. The values of the correlation coefficients for the dependences density - yield of fraction to 150°C and density - viscosity are equal to 0.72 and 0.80 respectively, confirming a monotonic nature of the interrelationship of these indices and the uniformity of compositions of the condensates. The interval between these lines corresponds to the error in determining density. Experience with work with the nomogram shows that if the analysis line between the two axes intersects the grid line more than once the errors in the values exceed the mean scatter.

As an example we will analyze data from an investigation of the characteristics of a stable condensate from the pool $Yu_1$ of the Severo-Vasyuganskoye deposit, which are shown in the figure by dashed lines. The results of analysis of a sample with a density 0.750 $g/cm^3$ are placed separately from the others. The high boiling point indicates that the product lost part of its light fractions. For the condensates with a density 0.723 there were errors in determining viscosity and its values must be excluded. The analysis of the condensate with a density 0.716 $g/cm^3$ is contradictory. The reduced viscosity and density values are probably caused by inadequate stabilization of the condensate and therefore it is best to discard them. As a result, we have five values for the yield of the fraction up to 150°C, four -- density, two -- viscosity, and we average each of these parameters.

Data from an analysis of condensates for all the petroleum- and gas-bearing regions of Western Siberia were plotted on such graphs. It was found: a) the indices for condensates of different regions are superposed on one another; b) on the average the monotonic nature of the correlation of parameters is retained; c) blunders in determining the values of the parameters are readily noted; d) on the basis of available data it is not possible to characterize the Yuzhno-Yamal'skaya petroleum- and gas-bearing region because with the small volume of results no tendency to grouping is observed.

As a result it can be stated that a method was developed for discriminating correct analyses of pure condensates. It should be noted that it does not contradict the important, for the most part intuitive, concepts on

Table 1

Characteristics of Condensates in Petroleum- and Gas-Bearing Complexes

| | Нефтегазоносная область 1 | Комплексы 2 | Плотность, г/см³ 3 | Вязкость, сСт 4 | Относительная молекулярная масса 5 | Температура, °C 6 | | Фракционный состав, %, t, °C 7 | | | | | Содержание 8 | | | Групповой состав УВ, % 9 | | | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | н. к. 11 | к. к. 12 | 100 | 150 | 200 | 250 | 300 | серы, % 13 | парафинов, % 14 | смол, мг/100 мл 15 | Мц 16 | Нф | Ар | [illegible] |
| 17 | Надым-Пурская | 24 Апт-сеноманский | 0,720 | 0,760 | 106 | 35 | 230 | | 78 | 90 | 96 | | 0,013 | | | | | | |
| | | 25 Готерив-аптский | 0,726 | 0,728 | 98 | 46 | 280 | 31 | 72 | 84 | 91 | | | | | | | | 2 |
| | | 26 Валанжин-готеривский | 0,737 | 0,842 | 103 | 40 | 280 | 32 | 62 | 77 | 89 | 95 | 0,010 | | | 61,14 | 29,09 | 9,82 | 30 |
| | | 27 Берриас-валанжинский | 0,740 | 0,874 | 104 | 38 | 302 | 30 | 60 | 76 | 88 | 94 | 0,011 | 0,30 | 14 | 60,25 | 29,85 | 10,40 | 25 |
| 18 | Пур-Тазовская | 24 Апт-сеноманский | 0,718 | 0,690 | 96 | 33 | 235 | 10 | 87 | 93 | 97 | | 0,00 | 0,00 | 0,00 | 60,27 | 39,18 | 0,55 | 1 |
| | | 26 Валанжин-готеривский | 0,724 | 0,760 | 106 | 43 | 285 | 39 | 76 | 90 | 95 | 97 | 0,010 | 0,15 | 0 | 65,03 | 28,12 | 6,85 | 2 |
| | | 27 Берриас-валанжинский | 0,739 | 0,873 | 104 | 38 | 303 | 29 | 61 | 79 | 88 | 95 | 0,009 | 0,12 | 1,0 | 57,99 | 35,91 | 6,10 | [illegible] |
| 19 | Гыданская | 25 Готерив-аптский | 0,731 | 0,760 | 111 | 35 | 300 | | 56 | 73 | 81 | 85 | 0,008 | 0,37 | | 50,10 | 29,10 | 20,80 | |
| 20 | Усть-Енисейская | 26 Валанжин-готеривский | 0,748 | 0,842 | 102 | 50 | 162 | 20 | 85 | | | | | | | | | | 1 |
| | | 27 Берриас-валанжинский | 0,746 | 0,778 | 106 | 38 | 295 | | 69 | 83 | 90 | | 0,010 | 0,41 | 1,16 | 45,79 | 42,90 | 11,31 | [illegible] |
| 21 | Среднеобская (Нижневартовский свод) | Готерив-аптский | 0,692 | 0,574 | 94 | 37 | | | 84 | 93 | | | 0,017 | 0,22 | 0,25 | 87,00 | 7,90 | 5,10 | 2 |
| | | 26 Валанжин-готеривский | 0,712 | 0,650 | 92 | 38 | | | 76 | 86 | 90 | | 0,026 | 0,20 | 0,47 | 74,20 | 16,40 | 9,40 | 2 |
| | | 27 Берриас-валанжинский | 0,694 | | 87 | 36 | | | 80 | 89 | 95 | | 0,027 | 0,77 | 1,94 | | | | [illegible] |
| 22 | Среднеобская (Сургутский свод) | 25 Готерив-аптский | 0,740 | 0,777 | 104 | 48 | | | 74 | 89 | 94 | | 0,180 | 0,19 | 0,37 | 64,57 | 29,91 | 5,52 | 3 |
| 23 | Томские земли (Каймысовская, Васюганская, Пайдугинская НГО) | 28 Валанжин-кулом-зинский | 0,714 | 0,920 | | 43 | | | 78 | 87 | 95 | | Следы 31 | | | 75,39 | 21,27 | 3,34 | 3 |
| | | 29 Ачимовский | 0,716 | 0,940 | | 40 | | | 70 | 88 | 94 | | | | | 72,70 | 22,47 | 4,88 | |
| | | 30 Юрский | 0,724 | 0,850 | | 42 | | | 64 | 79 | 88 | 94 | 0,104 | 0,00 | | 66,67 | 27,57 | 5,70 | 26 |

KEY TO TABLE 1

1. Petroleum- and gas-bearing region
2. Complexes
3. Density, g/cm$^3$
4. Viscosity, centistoke
5. Relative molecular mass
6. Temperature, °C
7. Fractional composition, %
8. Content
9. Group composition of hydrocarbons, %
10. Number of analyses
11. Begin boiling
12. End boiling
13. Sulfur
14. Paraffins
15. Tar, mg
16. ml
17. Nadym-Purskaya
18. Pur-Tazovskaya
19. Gydanskaya
20. Ust'Yeniseyskaya
21. Middle Ob' (Sredneobskaya) (Nizhnevartovskiy arch)
22. Middle Ob' (Surgutskiy arch)
23. Tomskiye Zemli (Kaymysovskaya, Vasyuganskaya, Payduginskaya petroleum- and gas-bearing regions)
24. Aptian-Cenomanian
25. Hauterivian-Aptian
26. Valanginian-Hauterivian
27. Berriasian-Valanginian
28. Valanginian—Kulomzinskiy
29. Achimovskiy
30. Yurskiy
31. Traces

Table 2

Limits of Confidence Intervals

| Petroleum- and gas-bearing complex | Strata | Density, g cm3 | Viscosity centistoke | Fraction yield* |
|---|---|---|---|---|
| Valanginian-Hauterivian (Nadym-Purskaya PGR) | $BU_1$-$BU_9$ | 0.718-0.760 | 0.69-1.00 | 51-75 |
| Berriasian-Valanginian (Nadym-Purskaya PGR) | $BU_{10}$-$BU_{14}$ | 0.718-0.766 | 0.72-1.02 | 52-66 |
| Yurskiy (Tomskaya Oblast) | $Yu_1$-$Yu_3$ | 0.700-0.746 | 0.65-1.08 | 52-80 |

[PGR = petroleum- and gas-bearing region]

[*Yield to 150°C, %]

the properties of the condensates, but makes them considerably more specific due to allowance for the interrelationships among the parameters.

A study of the results of 449 analyses by the considered method indicated that among them only 23% can be considered pure condensates. It is noteworthy that in the overwhelming majority of cases the rejected data were for those samples of condensate which were taken in violation of the instructions [2]. For the remaining analyses there could be a generalization of the characteristics of the condensates for petroleum- and gas-bearing regions and for stratigraphic horizons because their variations are comparable with the determination errors, which makes it possible to find the mean values without introducing weighting factors. These values (Table 1) can be regarded as a comparison standard for newly discovered pools and in computing predictions. It should be noted that the reliability of the computed values is directly related to the number of averaged analyses. For example, the petroleum- and gas-bearing complexes of the Berriasian-Valanginian and Valanginian-Hauterivian in the Nadym-Purskaya petroleum- and gas-bearing region and the Jurassic in Tomskaya Oblast can be considered fully studied. The distribution of the values of the characteristics in them conforms to a normal law, which is evidence of the correctness of the separation procedures carried out in the first stage of the work. The confidence intervals for the geological dispersion of discriminated complexes with a probability 0.95 are given in Table 2.

For a multidimensional criterion based on the limiting values indicated in Table 2 it is possible to compute the probability of appearance of a pool with a condensate whose characteristics do not fall in the three-parameter confidence intervals. Whereas for one parameter such a probability is equal to 0.05, for all three at the same time we obtain 0.0001. These values differ little from those obtained in an analysis of the real characteristics of heavy condensates, which confirms the objectivity of the latter.

It can therefore be concluded that the compositions of the condensates in Western Siberia are extremely uniform and the range of the change of their characteristics is rather narrow. This served as a basis for creating a method for the objective control of analyses, and applicable to the available archives of data made it possible to obtain the generalized characteristics of stable condensates in this region.

BIBLIOGRAPHY

1. GOST 16263-70 GSP (State Standard 16263-70 GSP), METROLOGIYA, TERMINY I OPREDELENIYA (Metrology, Terms and Definitions), Moscow, Izd-vo Standartov, 1970.

2. INSTRUKTSIYA PO ISSLEDOVANIYU GAZO-KONDENSATNYKH MESTOROZHDENIY NA GAZO-KONDENSATNOST' (Instructions on Investigation of Gas Condensate Deposits for Gas Condensate Content), Moscow, Nedra, 1975.

3. Savvina, Ya. D., Velikovskiy, A. S., "Fractional Composition of Condensates -- Search Criterion for the Presence of Fringes of the Condensate Type in a Gas Condensate Stratum," GAZOVOYE DELO (Gas Industry), No 12, pp 10-14, 1968.


[37-5303]

5303
CSO: 1822

FUELS AND RELATED EQUIPMENT

UDC 550.4.553.982(571.1)

STUDY OF COMPOSITION OF ISOMERIC PHENOLS IN WESTERN SIBERIAN PETROLEUMS

Moscow GEOLOGIYA NEFTI I GAZA in Russian No 7, Jul 79 pp 19-21

[Article by I. V. Goncharov, West Siberian Petroleum Scientific Research Institute for Geological Survey, B. A. Lugovik, Omsk State University, V. I. Kulachenko and G. B. Nemirovskaya, Institute of Chemical Sciences Siberian Department USSR Academy of Sciences, submitted for publication 26 December 1978]

[Text] The study of the distribution of different classes of compounds in petroleums and a knowledge of the quantitative relationships of isomers makes it possible to detect important regularities indicating the character and direction of the chemical evolution of petroleum. However, until now such investigations have been carried out for the most part for hydrocarbons.

The isomeric composition of phenols is one of the geological-geochemical indices used in the search for petroleum.

The petroleums in the deposits of Western Siberia differ sharply with respect to the depth at which they occur, density, content of tars, asphaltenes and sulfur. In the Fedorovskoye deposit the petroleums are of the naphthene type whereas in the Kalinovoye and Urmanskoye deposits they are typically of the methane type (see Table).

The phenols are extracted from the petroleum with a 10% alkali solution. The concentrates obtained after neutralization were analyzed using an LKhM-8MD chromatograph with a flame-ionization detector. The identity of the phenols was established by analogy with the published data [5] and also on the basis of use of individual compounds. This was done using chromatograms with dinonyl phthalate, giving the best separation. In this phase the phenols emerge in the following sequence: phenol, o-cresol, 2,6-xylenol, p-cresol, m-cresol, o-ethyl phenol, 2,4-xylenol, 2,5-xylenol, 2, 4, 6-trimethyl phenol (TMP, 2,3- and 3,4-xylenols, o-isopropyl phenol and 2,3,6-TMP, 3,5-xylenol. All the quantitative computations were made for these compounds.

The hydrocarbon composition was determined by making chromatographic measurements of the fraction $C_5$-$C_9$ in a capillary column with squalene. The identification was made by analogy with the data in [3].

All the petroleums differed with respect to the total content of phenols. It is characteristic that it does not have an apparent relationship to such indices as density, presence of tars, asphaltenes and depth.

Patterns not discovered when determining the total content of phenols are clearly detected when examining their isomeric composition. A chromatographic analysis indicated that the relationships between different alkyl phenols vary in a wide range. There was a considerable difference in the quantitative compositions of phenols not only from petroleums of different deposits, but also from different boreholes in the very same deposit. A dependence of composition on the depth of the petroleum is traced. It was most clearly expressed for phenol itself and cresols, and also for sterically intricate phenols. The content of such compounds as 2,4-, 2,5- and 3,5-dimethyl phenols (DMP) remains at approximately the same level.

The figure shows the change in the quantity of individual alkyl phenols in the sum of phenols. With an increase in depth the content of the phenol itself decreases sharply. For example, for the petroleums of the Fedorovskoye deposit with a depth drop of only 617 m it decreases from 14.5 to 0.36%, that is, by a factor of 40. For the remaining deep-lying petroleums the phenol fraction is less than 0.5%.

With increasing depth there is also a considerable decrease in the quantity of cresols, although not so sharply as phenols. For example, in these same Fedorovskiye petroleums -- by less than a factor of 5. At the same time, the fraction of sterically complex phenols increases. Whereas the content of 2,6-DMP from Fedorovskaya petroleum varies by only a factor of 3.3 to the Urmanskaya petroleum, 2,4,6-TMP varies by a factor of 20 (see Figure).

Thus, with increasing depth of the petroleum the quantitative composition of the alkyl phenols changes substantially, that is, the fraction of the most reaction-capable compounds decreases, whereas the fraction of relatively inert compounds increases. It is probable that under the catalyzing influence of rocks the phenols enter into different thickening reactions. Their rates will be determined, in particular, by the temperature and the interaction of the alkyl phenol [6]. With an increase in temperature, all other conditions being equal, due to a decrease in the active compounds there is an increase in the fraction of less active compounds.

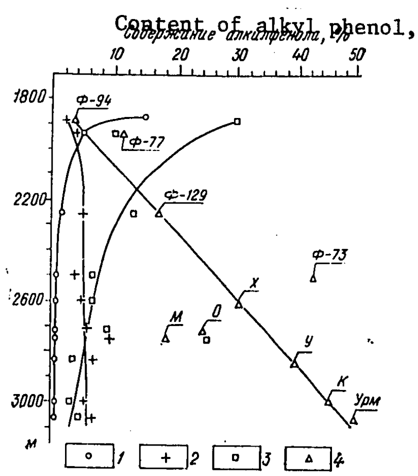
To be sure, the investigated samples are inadequate for a more rigorous validation of this hypothesis. It is probable that the discovered patterns and especially the dependence of the content of 2,4,6-TMP on depth are universal for this region. The points characterizing the dependence

Characteristics of Studied Petroleums

| Месторождение 1 | Номер скважины 2 | Пласт 3 | Возраст 4 | Интервал перфорации, м 5 | Плотность, г/см³ 6 | Состав нефтей 7: Смолы, % 8 | Асфальтены, % 9 | Сера, % 10 | Сумма фенолов, мг/л 11 | н-Парафины / изопарафины 12 | Парафины / нафтены 13 | 2, 4, 6-ТМФ / 2,4-ДМФ 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Федоровское 15 | 94 | $АС_6$ | $K_1$ | 1884—1888 | 0,9189 | 6,4 | 2,7 | 1,56 | 41,4 | 0,11 | 0,6 | 0,2 |
| » | 77 | $АС_9$ | $K_1$ | 1931—1937 | 0,8978 | 9,6 | 2,7 | 1,35 | 143,0 | 0,29 | 1,2 | 0,42 |
| » | 129 | $БС_{10}$ | $K_1$ | 2249—2252 | 0,9030 | 8,1 | 4,1 | 1,84 | 40,2 | 0,89 | 1,4 | 0,72 |
| » | 73 | $БС_{15}$ | $K_1$ | 2498—2505 | 0,8917 | 7,3 | 1,9 | 0,75 | 128,0 | 1,01 | 1,5 | 1,87 |
| Малоичское 16 | 2 | — | PZ | 2750—2851 | 0,8493 | 10,1 | 4,1 | 0,51 | 90,0 | 1,06 | 1,6 | 1,12 |
| Останинское 17 | 438 | — | PZ | 2750—2755 | 0,8543 | 5,8 | 2,7 | 0,16 | 45,5 | 0,96 | 2,0 | 0,75 |
| Холмогорское 18 | 41 | $БС_{11}$ | $K_1$ | 2595—2600 | 0,8504 | 6,9 | 2,2 | 0,51 | 95,0 | 1,04 | 1,7 | 1,26 |
| Уренгойское 19 | Р—86 | $БУ_{11}$ | $K_1$ | 2825—2829 | 0,7588 | 2,3 | 0,1 | 0,12 | 216,0 | 1,02 | 1,2 | 2,12 |
| Калиновое 20 | 6 | — | 22 Кора выветривания | 2990—3005 | 0,7970 | 5,7 | 1,3 | 0,53 | 92,0 | 0,98 | 2,5 | 2,10 |
| Урманское 21 | 1 | — | 23 То же | 3060—3073 | 0,8645 | 6,2 | 1,6 | 0,62 | 276,0 | 0,89 | 2,2 | 3,68 |

KEY:
1. Deposit
2. Number of borehole
3. Stratum
4. Age
5. Drilling interval, m
6. Density, g/cm³
7. Composition of petroleums
8. Tars, %
9. Asphaltenes, %
10. Sulfur, %
11. Sum of phenols, %
12. n-paraffins/isoparaffins
13. Paraffins/naphthenes
14. ...TMP/...DMP
15. Fedorovskoye
16. Maloichskoye
17. Ostaninskoye
18. Kholmogorskoye
19. Urengoyskoye
20. Kalincvoye
21. Urmanskoye
22. Weathered crust
23. Same

of the content of 2,4,6-TMP on depth fall rather well on the straight line. An exception is the Fedorovskaya petroleum, but also Ostaninskaya and Maloichskaya petroleums. And if for explanation of the deviation of Fedorovskaya petroleum it is possible to assume vertical migration, the downward movement of Maloichskaya and Ostaninskaya petroleums is improbable. But precisely these, in contrast to all the others, associated with the terrigenous rocks of the Mesozoic, are Paleozoic and lie in calcareous deposits [4]. Apparently, the low 2,4,6-TMP content in these petroleums was caused by a lesser catalytic activity of the calcareous rocks in comparison with terrigenous rocks.




Change in content of alkyl phenol with depth at which petroleum is found. 1) phenol; 2) 2,6-DMP; 3) sum of cresols; 4) 2,4,6-TMP; areas: Ф -- Fedorovskoye; X -- Kholmogorskaya; O -- Ostaninskaya; M -- Maloichskaya; У -- Urengoyskaya; K -- Kalinovaya; У pm -- Urmanskaya

Proceeding on the assumption that the observed correlation between the composition of phenols and the depth of the petroleum is a result of the effect exerted on petroleum by temperature and the rock catalyst, we made an attempt to relate the quantitative composition of phenol and the degree of transformation of petroleums. Different criteria are known for determining the degree of transformation of petroleum on the basis of the change in their hydrocarbon composition [1, 2]. However, they do not always make it possible to give an objective evaluation.

As an index of the effect of the medium on petroleum we took the ratio of 2,4,6-TMP to 2,4-DMP (see Table). It successively increases with the depth of the petroleums, excluding only the Fedorovskaya, Maloichskaya and Ostaninskaya petroleums. The possible factors causing this phenomenon were considered above. Thus, the ratio of isomeric phenols (2,4,6-TMP/2,4-DMP) can serve as a measure of the catagenetic transformation of petroleum. The ratio of n-paraffins to isoparaffins increases regularly to a definite depth and then remains almost at the same level.

## BIBLIOGRAPHY


1. Bogomolov, A. I., Stepina, L. F., Ankudinova, V. P., Kordus, V. I., "Gas Chromatographic Analysis of Isoprene Hydrocarbons in Petroleums and Condensates," TRUDY VNIGRI (Transactions of the All-Union Petroleum Scientific Research Institute of Geological Prospecting), No 371, pp 11-16, 1975.

2. Dobryanskiy, A. F., KHIMIYA NEFTI (Petroleum Chemistry), Leningrad, Gostoptekhizdat, 1961.

3. Petrov, Al. A., KHIMIYA ALKANOV (Chemistry of Alkanes), Moscow, Nauka.

4. PROBLEMY NEFTEGAZONOSNOSTI PALEOZOYA NA YUGO-VOSTOKE ZAPADNO-SIBIRSKOY NIZMENNOSTI (Problems in the Presence of Petroleum and Gas in the Paleozoic in the Southeastern Part of the West Siberian Lowland," edited by A. A. Trofimuk and V. S. Vyshemirskiy, Novosibirsk, Nauka, 1976.

5. Sidorov, R. I., Borovskaya, I. S., "Identification of Phenols in Complex Mixtures," ZHURNAL ANALITICHESKOY KHIMII (Journal of Analytical Chemistry), No 4, pp 576-578, 1974.

6. Kharlampovich, G. D., Churkin, Yu. V., FENOLY (Phenols), Moscow, Khimiya, 1974.



[37-5303]

5303
CSO: 1822

FUELS AND RELATED EQUIPMENT

UDC 553.98.041:551.73(-925.22-14)

## OIL POTENTIALS OF ASTRAKHAN ARCH INVESTIGATED

Moscow GEOLOGIYA NEFTI I GAZA in Russian No 6, Jun 79 pp 1-5

[Article by N.V. Mizinov (NVTGU), A.S. Zinger, V.G. Grushevoy, N.I. Voronin (NVNIIGG): "Oil-Bearing Prospects of Subsalt Deposits of the Astrakhan Arch"]

[Text] At a number of sites of the Astrakhan Arch, located in the limits of the southwestern part of the Caspian depression, in recent years high-capacity gas gushers have been obtained, evidencing the opening of the Astrakhan gas condensate deposit [7]. The productive layer, lying in the interval of 3950-4100 meters, is represented by organogenic-detrital limestones of the Bashkir stage. The yield of gas condensate on a 14.8 millimeter flow regulator has reached 560 cubic meters per day, the bed pressure is 63 MPa, and the gas condensate factor came to 240 cubic centimeters per cubic meter. The fractional composition of the stable condensate is as follows (percent by volume): $100^{\circ}$-8; 150-31; 200-50; 250-63; 300-73; 350-81; the residue is equal to 15.5.

Obtained in the Shiryayevskaya well from an interval of 4184-4202 meters was a flow of bed water with gas, but without signs of oil. The free gas contains the following components (in percent by volume): $C_1$--46.33; $C_2$--4.2; $C_3$--1.83; $C_4$--1.5; $C_5$--0.9; $C_6$--0.94, $C_7$--traces; $N_2$--traces; $CO_2$--24.3; $H_2S$--20. The results of the field-geophysical studies of the unstudied part of a cross-section of this well (4100-4182 meters) are contradictory and do not allow us to make an unequivocal judgement about the presence of reservoirs here and the character of their saturation. When sampling the lower carboniferous deposits in Shiryayevskaya well 1, located 18 kilometers to the north of well 5 (beyond the gas-bearing contour), flows of bed waters with films of oil were obtained from the intervals of 4650-4670, 4580-4590, and 4396-4410 meters.

Thus, an oil fringe was not detected at the Astrakhan deposit. Based on the value of the condensate factor it is possible to assume that it is absent here or is very insignificant. According to the data of T.P. Zhuze [2], the solubility of oils of different group composition in compressed gases at a temperature of 50°C and a pressure of 40 MPa comes to 350-500 grams per cubic meter. It is probable that gas of the Astrakhan deposit (bed pressure 63 MPa, temperature 110-120°C, condensate factor about 200 grams per cubic centimeter) is undersaturated with oil.

The discovery of oil deposits in structures of the middle carboniferous reservoir on the periphery of the Astrakhan arch is highly improbable. Differentiation of the oil and gases in the gravitational field according to the principle of S.P. Maksimov and U.V. Gassou ultimately leads to that liquid UV [not further identified] fill the higher traps. Available geological-geophysical material indicates that the prospected sites (Shiryayevskaya, Aksarayskaya, Volozhkovskaya) are related to the most elevated section of the Astrakhan arch along the roof of the productive bed, and the oil which has migrated from loaded peripheral traps should be accumulated namely in these structures. In the gas of the Astrakhan deposit about 200,000 tons of oil is dissolved in 1 billion cubic meters. In the opinion of the authors, these values do not reflect the ratios of the oil- and gas-generating potentials of the studied part of the cross-section, and the processes of oil accumulation take place less intensively than gas accumulation.

Deserving of much attention is the presence in free and water-soluble gases of the carboniferous water-bearing complex of significant quantities of hydrogen sulfide and carbon dioxide. With practically equal concentrations of them the content of acid components in the gas of the Astrakhan deposit reaches 50 percent, and in water-soluble gases 70-90 percent, and the gas saturation level of underlying waters in Shiryayevskaya well 5 comes to 17,500 cubic centimeters per liter.

The genesis of hydrogen sulfide in the sedimentary thickness has been the subject of debate for many years. At the present time generally acknowledged and demonstrated experimentally is the possibility of formation of hydrogen sulfide during biogenic and abiogenic restoration of sulfates of UV and destruction of the sulfur-containing components of oil.

Formation of gas deposits with high concentrations of hydrogen sulfide is connected with processes of chemical interaction of UV with sulfates. The reaction of methane with the sulfate ion is energetically insured at temperatures exceeding 23°C, and with an increase in the temperature its speed increases [4].

The large quantities of hydrogen sulfide and carbon dioxide in the carbonate section of carboniferous deposits indicate that the sulfate-reducing processes have had a substantial effect on the scales of oil accumulation. The concentrations of these components in the bed waters are very close to one another, which to a certain degree indicates their paragenesis and makes it possible to consider the processes mentioned as their basic source. The gas saturation level of subadjacent bed waters in Shiryayevskaya well 5 with respect to carbon dioxide comes to about 8 l/l. Assuming that this value is stipulated by the closeness of the well to the gas-water interface (GVK; gazovodyanoy kontakt), taken for calculation is the average gas-saturation for carbon dioxide of 2 l/l. With the capacity of the complex at 1 kilometer, and the average porosity of 5 percent, contained in the bed waters is about 200,000 tons of carbon dioxide per 1 square kilometer of area. The formation of such an amount of it owing to oxidation of the UV requires 64,000 tons of standard fuel recalculated for the methylene radical. Thus, in the limits of the Astrakhan arch (on an area of 20,000 square kilometers) required for formation of the carbon dioxide found in the carbonate carboniferous deposits was the oxidation of over 1 billion tons of standard fuel. In addition, contained in 1 billion cubic meters of the gas of the Astrakhan deposit is about 500,000 tons of carbon dioxide and in order to produce such an amount of carbon dioxide it would have been necessary to oxidize 66,000 tons of standard fuel. Keeping in mind that the energy threshold of the sulfate-reduction reaction is reduced with an increase in the molecular mass of UV, it is possible to expect that mainly the liquid UV were subject to oxidation.

Isolation of the regional oil and gas confining beds is a necessary criterion of differentiated evaluation of the conditions of formation of UV deposits in reservoirs of the unstudied part of the layer of subsalt deposits. At the given stage this question is being solved by making analogies with well-studied adjacent territories, and also according to the results of geophysical investigations.

There are developed Devonian, carboniferous and Permian deposits in the northwest frame of the Caspian depression in the subsalt layer. Regionally mature oil and gas confining beds were formed primarily during terrigenous sedimentation and are represented by argillites of the mull horizon, and also by clays in the roof of the Tula and Vereian horizons. The higher complex is covered with a salt-bearing layer of kungur. Singled out in accordance with this are the pre-mull, pre-Tula, pre-Vereian and pre-Kungur water-bearing complexes.

The uncovered part of the subsalt layer in the center of the Astrakhan arch is represented by silico-argillaceous rocks of Sakmara-Artinsk age, lying under which, with stratigraphic variance, are carbonates of the Bashkir stage. The regional development of deposits of the upper Carboniferous period and the Moscow stage on adjacent territories, and the different age of the rocks in the roof of the Bashkir stage on the Astrakhan arch make it possible to assume that at the interface of the Carboniferous and Permian periods here intensive denudational processes occurred, destroying a significant part of the carboniferous sediments.

The Bashkir stage and the revealed part of the lower-carboniferous deposits are an analog of the pre-Vereian water-bearing complex of the frame of the depression. The Vereian oil and gas confining bed, probably, comes out at the pre-Permian variance surface on the periphery of the arch.

The analog of the pre-Kungur water-bearing complex in the central part of the Astrakhan arch is represented by a clayey-gravelly layer of Sakmara-Artinsk age, practically devoid of collectors, however on the periphery this complex should be intensively developed owing to the appearance in the layer of sediments of the Moscow stage and the upper Carboniferous period. Here, in the zones of outcropping of water-conducting layers on the surface of the washout under salt-bearing sediments vast lithologically shielded traps were able to form.

Traced quite clearly within the salt-bearing formations are seismic deflecting horizons [3] which can be related to the Tula and mull oil and gas confining beds. Thus, on the Astrakhan arch it follows to expect the development of analogs of the pre-Tula and pre-mull water-bearing complexes.

In the central part of the Astrakhan arch on the boundary of the Carboniferous and Permian periods the denudational processes had a substantial effect on the conditions of preservation of the deposits of oil and gas. Even by the end of the Carboniferous period the deposits of the pre-Vereian water-bearing complex could be found at depths insuring adequately severe thermobaric conditions for the onset of the chief phase of oil formation (GFN; glavnaya faza nefteobrazovaniya). The depth of submersion of the rocks of the given complex on the periphery of the Astrakhan arch and in the Sarpa megatrough can be estimated according to the results of drilling in adjacent territories. In the Saratov-Volgograd Volga region the capacity of the sediments of the Moscow stage and the upper Carboniferous exceeds 900 meters, and at the Karasal'skiy monoclinal in Stepnaya well 1 it has passed over 1000 meters with respect to deposits of the upper Carboniferous.

Proceeding from the fact that the capacities of individual subdivisions of the Paleozoic in the Sarpa megatrough and on the periphery of the Astrakhan arch grow in proportion to an increase in the overall capacity of the sediments, it is possible to assume that the deposits of the complex in areas of intensive deflection by the end of the Carboniferous sediment accumulation were in the interval of depths of 2-4 kilometers. Taking the average paleothermogradient as equal to the present one (2.9°C/100 meters), the calculated temperatures at these depths were 58-116°C, which insured the intensity of the oil and gas generating processes and the formation of UV deposits on the Astrakhan arch.

Erosion of the Vereian oil and gas confining bed caused destruction of the deposits and flooding of the whole complex. Available factual material confirms this assumption to a significant degree. Thus, characteristic for zones of ancient VNK (vodno-neftyanoy kontakt; water-oil interface) are associations of authigenic catagenetic minerals: chalcedony, pyrite, calcium carbonate and oxidized bitumen. Their appearance is connected with the oxidation-reduction reaction between the oil and the sulfates of the bed waters in the zone of the water-oil interface with the formation of hydrogen sulfide and carbon dioxide [1]. These associations are typical for the profile of Bashkir and lower Carboniferous deposits uncovered on the Astrakhan arch which, possibly, indicates a shift of the water-oil interface in the process of flooding of the oil deposits. The residual oil saturation of the rocks, which is indicated by the flows of water with an oil film from Shiryayevskaya well 1, also can be explained by the flooding of an oil deposit which existed previously.

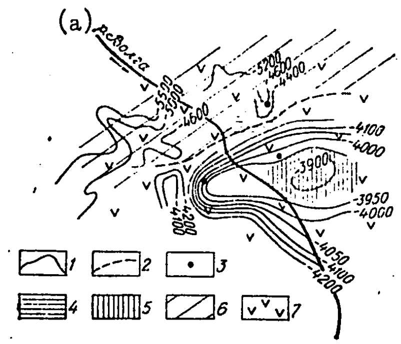
After accumulation of the Kungur salt-bearing thickness in the pre-Vereian water-bearing complex favorable conditions were again created for oil and gas accumulation. The oil generating potential of this complex had been exhausted considerably even in the Carboniferous period. Further submersion caused the dominance of gas-generating processes over oil and gas generating processes, as a result of which the gas-condensate deposits were formed.

The deposits of the pre-Kungur water-bearing complex were under more favorable conditions of oil and gas accumulation. The main phase of oil formation here began after formation of the traps under the salt-bearing layer, and the pre-Permian erosion did not have a substantial effect on the scales of oil and gas accumulation.

The conditions of preservation of the liquid UV can be determined according to the lithological-facial characteristics of the surrounding rocks. In the terrigenous collectors, isolated from the sulfate-containing sediments, the processes of sulfate-reduction are weakly developed and fade away without accumulation of free hydrogen sulfide, since the resources of the sulfates are exhausted earlier than the resources of the active forms of iron oxides which bind the hydrogen sulfide [6]. By analogy with the profile of the Paleozoic era of the northwest framework of the depression, it can be expected that the upper part of the Bashkir stage and the Vereian horizon are composed primarily of terrigenous formations. Thus, it is very probable that terrigenous reservoirs, in which the conditions of formation and preservation of oil deposits have been more favorable in comparison with the lower ones will be uncovered in the pre-Kungur water-bearing complex on the periphery of the Astrakhan arch.

As the first stage of explorations in this complex it is advisable to conduct geophysical work along the periphery of the Astrakhan arch in order to reveal the zones of stratigraphic cutting in the deposits of the Moscow stage and the upper Carboniferous (see the illustration). After specifying the position of these zones it is proposed to cut a number of parametric wells in order to study the profile and determine the prospects of the presence of oil and gas.

A second direction of exploration and prospecting studies is the unstudied part of the profile of subsalt deposits in the center of the Astrakhan arch (pre-Tula and pre-mull water-bearing complexes). The depths of submersion of the complexes (5-7 kilometers) make it possible to assume that their oil and gas generating potential was the most fully realized, and with favorable conditions here it would have been possible for both




Schematic Map of Oil Content Prospects

Key:
1. Isohypses along the deflecting horizon $P_1$, meters
2. Proposed line of thinning of the Vereian[1] oil and gas impervious bed
3. Wells; sections recommended for exploration and prospecting
4. In the pre-Kungur complex
5. In the pre-Tula and pre-mull; territories, promising
6. Along the pre-Kungur complex (deposits of the lithologically shielded type)
7. Along the Devonian-lower Carboniferous

a. Volga river

oil and gas deposits to be formed. The questions of the possibility of preserving liquid UV under such severe thermobaric conditions (pressure 75-90 MPa, temperature 150-190°C) is debatable, however in world practice cases of obtaining flows of oil under analogous conditions are known [5].

It is proposed to drill two wells with a depth of 5.5 kilometers each at the pre-Tula and one of 6.5 kilometers at the pre-mull complexes. Their location will be found after geophysical work is done to establish these horizons.

Thus, the data presented indicate the possibility of discovering oil deposits in the subsalt deposits of the Astrakhan arch and predetermine the advisability of setting up geological-geophysical work to search for them.

LIST OF REFERENCES

1. Alekseyeva, M.A., Kaleda, G.A., "On the Period of Formation of Oil Deposits in Carbonate Collectors According to Epigenetic Changes in the Rocks," GEOLOGIYA NEFTI I GAZA, No 9, 1975, pp 41-46.

2. Zhuze, T.P., "Szhatyye gazy kak rastvoriteli" [Compressed Gases as Solvents], Moscow, Nauka, 1974.

3. Ye.I. Ben'ko, A.Ya. Brodskiy, I.A. Mitalev, A.T. Yakovlev, "New Idea About the Structure and Formation of the Astrakhan Paleozoic Arch," NEFTEGAZ. GEOL. I GEOFIZ., No 6, 1977, pp 46-48.

4. G.I. Amurskiy, I.P. Zhabrev, E.S. Goncharov and others, "Substantiation of Separate Searches for Deposits of Nonsulfurous and Hydrogen Sulfide Containing Gases," NAUCHN.-TEKHN. OBZOR. SER. GEOL. I RAZV. GAZOVYKH I GAZOKONDENSATNYKH MESTOROZHDENIY, Moscow, VNIIGAZprom, 1975, p 48.

5. N.M. Arutyunova, N.I. Vysotskiy, L.N. Grdzelov and others, "Poiski nefti i gaza na bol'shikh glubinakh za rubezhom" [Searches for Oil and Gas at Great Depths Abroad], Moscow, VNIIOENG, 1978, p 34.

6. G.I. Amurskiy, E.S. Goncharov, I.P. Zhabrev, N.N. Solov'yev, "Origin of Hydrogen Sulfide Containing Natural Gases of Oil and Gas Bearing Basins," SOV. GEOLOGIYA, No 5, 1977, pp 56-69.

7. Rovnin, L.I., Mizinov, N.V., Voronin, N.I., "Discovery of a Gas Deposit on the Astrakhan Arch and the Goals of Further Exploration and Prospecting," GEOLOGIYA NEFTI I GAZA, No 10, 1977, pp 41-43.

Submitted 29 November 1978



10908
CSO: 1822

FUELS AND RELATED EQUIPMENT

UDC 553.98:550.812.1 (575.1)

## OIL, GAS PROSPECTING IN WESTERN UZBEKISTAN SURVEYED

Moscow GEOLOGIYA NEFTI I GAZA in Russian No 6, Jun 79 pp 15-18

[Article by I.P. Sokolov, and N.A. Zelenin (SredazNIIGaz): "New Targets for Exploration and Prospecting for Oil and Gas in Western Uzbekistan"]

[Text] In the old oil and gas bearing regions, among which is Western Uzbekistan, almost all the ascertained promising traps for oil and gas of significant sizes either have already been prospected or are being prospected. The difficulty in searches for new possible traps in these regions is usually conditioned by the low amplitude of the structures, by the complex structure of folds destroyed by faults, and the inadequate development of the method of detecting lithological, shielded and other types of non-anticlinal traps. In such regions there is usually a significant rise in expenses for exploratory work with their steadily declining effectiveness.

Certain positive results in the revelation of individual specific sections for setting up detailed exploratory work and preparing them for prospecting can be given by a complex geological analysis of all the geological information. As an example of such an approach, presented below are the materials of an analysis of the map of capacities of deposits of the Eocene age, which have been preserved from the pre-Neogenic denudational shearing and covered by continental layers of the Neogene; analysis of the paleogeological map of the surface of erosion of pre-Neogene formations; of a structural map for the roof of rocks of the Paleocene; and a structural map of the surface of the pre-Neogenic denudational shear of the southeastern part of Western Uzbekistan.

An analysis shows that almost all deposits of oil and gas in Western Uzbekistan are related to folds of early deposition, which have developed inheritedly over the extent of the whole history of formation of the sedimentary mantle. As a rule, such folds are rather clearly established in deposits of the Neogene-Anthropogene also, and corresponding to them is the maximum erosional shear of the pre-Neogenic formations. In later phases of Alpine folding (Neogene-Anthropogene) these structures in the majority of cases have experienced further growth.

Along with this on the examined territory with respect to local reduction of the capacity of deposits of the Eocene, and in places also of more ancient formations, singled out rather clearly are the sections of development of low-amplitude partially or fully separated folds, which in the contemporary structural plane with respect to the upper horizons (Paleocene) either are not depicted at all or are established in the form of complications of the open contour.

It should be assumed that such local sections of reduced capacity of Eocene rocks in the limits of the exterior closing isopach or the more ancient formations touched by pre-Neogenic erosion (Paleocene, Senonian, Turonian) corresponded to pre-Neogenic local folds which underwent denudation and then were buried under the mantle of continental deposits of the Neogene-Anthropogene.

The tectonic movements of the Neogene-Anthropogene period, which brought about the modern structural plan, had a different effect on folds of earlier deposition. In some cases these greatly increased their amplitude, in others they partially or fully broke up these folds or did not touch them at all and, finally, they formed new structures, independent of those which had existed earlier.

In this way it is possible to single out the structures of the early (pre-Neogenic) deposit, and among them also the paleofolds (paleostructures) not depicted in the modern plan with respect to the upper horizons, and the folds of the young (Neogene-Anthropogene) deposit and development, the neostructures brought about by neotectonic movements.

As was noted above, the structures clearly expressed in the modern plan basically have already been prospected. Also in the prospecting stage are many neo-folds, and sometimes of very limited sizes, although there has not been any output at any one of them.

Not covered by prospecting are only the paleofolds which were not depicted in the modern structural plan and were established only by reduction of the capacity of the upper part of the cross-section of pre-Neogenic deposits. Such paleostructures are usually not counted in the fund of revealed structures, although some of them, in our opinion, undoubtedly are of definite interest as new targets for setting up detailed explorations and preparation for prospecting.

Judging by the preserved capacity of deposits of the Eocene, the elevation of such paleofolds in the pre-Neogenic period was not high in the majority of cases, therefore in connection with the reorganization of the structural plan in the Neogene-Anthropogene period in the upper horizons closed forms of them are not reflected. However the degree of their separation with respect to upper-Jurassic carbonate deposits, distinguished by regional oil and gas content, can be ascertained by drilling and in individual cases by seismic surveying.

In the majority of cases the structural plan for carbonate deposits of the Jurassic is expressed with more contrast than for the upper horizons of the Cretaceous and Paleogene. This gives the basis to assume that the paleofolds broken up along the upper horizons can preserve the closed forms of the traps for oil and gas in the lower horizons.

For instance, the small fold of the Severnyy Urtabulak oil deposit along the roof of limestones of the Upper Jurassic, 3X2 kilometers in size and with a height of about 200 meters, coincides in the plan with the paleofolds with expressed reduced capacity of Eocene deposits, the height of which in the limits of the external closed isopach comes to a total of only about 30 meters, and it is not established in the modern structural plan with respect to the upper horizons (Paleocene).

The Akkum and Parsankul' gas-condensate deposits are related to low-amplitude folds in Callovian-Oxford limestones. Their height along the roof of limestones XV-I of the productive horizon is respectively 10 and 15 meters. The course of the paleofolds is northeast, while for modern folds it is northwest. These structures are not deflected along the roof of deposits of the Paleocene in the modern plan. An analysis shows that the Akkumskoye and Parsankul'skoye paleo-uplifts of pre-Neogenic deposition and development, apparently, contained accumulations of gas in the carbonate and, possibly, also in the terrigenous horizons of the Jurassic. In the Neogene-Anthropogene period these paleostructures underwent considerable reorganization. Two independent folds, small in height--the Akkumskoye and Parsankul'skoye--have been isolated.

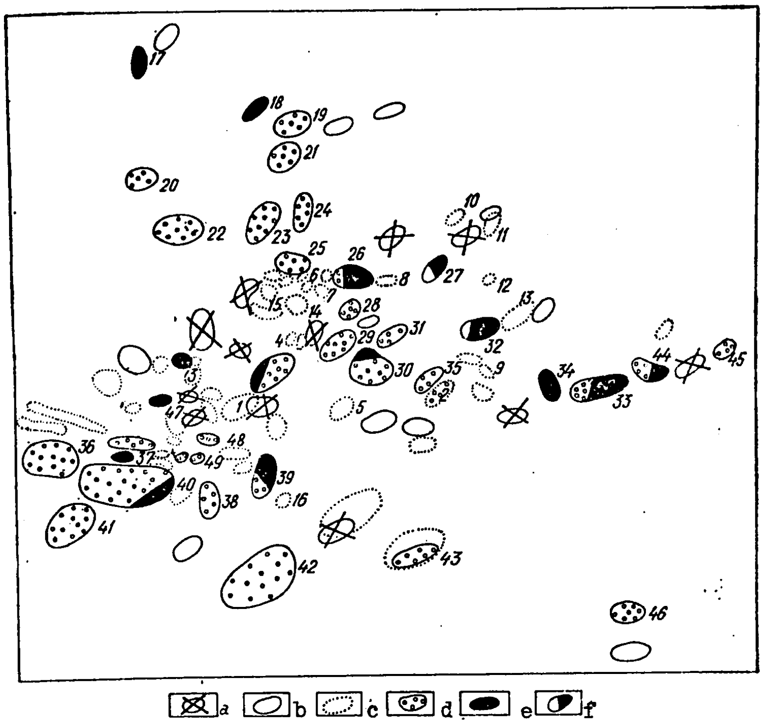
In connection with the reorganization of the structural plan in the Neogene-Anthropogene period there was also a reshaping of the deposits of gas in accordance with the new structure and position of the traps. It has not been excluded that also connected with this is a certain change in the collector properties of the productive horizons and the inclined position of the gas-water interface.

It should be assumed that it is possible to relate to certain paleo-elevations, just as to the extensions of the paleozoic foundation, the zones of development of the lower and middle Jurassic terrigenous horizons with increased collector properties.

Thus, the presence of paleofold at deposits of Severnyy Urtabulak, Akkum and Parsankul' confirms the fundamental possibility of discovery of productive traps in the lower horizons of the Mesozoic.

In the limits of the southeastern part of Western Uzbekistan it appears possible by complex geological analysis to single out about 30 paleostructures not established in the modern structural plan for the upper horizons.

A description of some of the largest of these is given in the table.




General Map of Deposits of Gas, Oil and Structures of the Eastern Part of the Amu-Dar'ya Depression

Structures: a) withdrawn from prospecting, b) recently explored, c) identified and proposed paleostructures (names of 1-16, see table); Deposits: d) gas, e) oil, f) gas-oil (17 - Kuyumazarskoye, 18 - Karaizskoye, 19 - Shurchinskoye, 20 - Mamadzhurgatinskoye, 21 - Andzharskoye, 22 - Sarytashskoye, 23 - Dzharkakskoye, 24 - Setalantepinskoye, 25 - Yulduzkakskoye, 26 - Shurtepinskoye, 27 - Kyzylrabatskoye, 28 - Shumanskoye, 29 - Severo-Mubarekskoye, 30 - Yuzhno-Mubarekskoye, 31 - Khadzhikhayramskoye, 32 - Karabairskoye, 33 - Tashkul'skoye, 34 - Karakumskoye, 36 - Dengizkul'skoye, 37 - Severo-Urtabulakskoye, 38 - Severo-Zevardinskoye, 39 - Pamukskoye, 40 - Urtabulakskoye, 41 - Mekhedzhanskoye, 42 - Kultakskoye, 43 - Kamashinskoye, 44 - Sarychinskoye, 45 - Uvadinskoye, 46 - Shurtanskoye, 47 - Yuzhno-Zakrinskoye, 48 - Pirnazorskoye, 49 - Markovskoye)

| Structure Number | Paleofolds | Dimensions of Paleofolds | | |
|---|---|---|---|---|
| | | Length, km | Width, km | Height, meters |
| 1 | Ispanly-Darbazinskaya | 15 | 5.5-6.5 | 60 |
| 2 | Kassanskaya | 8 | 2.5 | 10 |
| 3 | Vostochno-Zekrinskaya | 6 | 2.6 | 20 |
| 4 | Kashkadar'inskaya | 2.8 | 1.6 | 5 |
| 5 | Karlykskaya | 2.7 | 1.6 | 10 |
| 6 | Zapadno-Shurtepinskaya I | 4.5 | 1.5 | 10 |
| 7 | Zapadno-Shurtepinskaya II | 3.5 | 2.5 | 10 |
| 8 | Vostochno-Shurtepinskaya | 6.5 | 4.0 | 10 |
| 9 | Pulatinskaya | 3.5 | 1.7 | 10 |
| 10 | Zapadno-Chembarskaya | 7.5 | 2.5 | 10 |
| 11 | Vostochno-Maydadzhoyskaya | 8 | 2.5 | 10 |
| 12 | Yugo-Vostochno-Maydadzhoyskaya | 4 | 1.4 | 10 |
| 13 | Vostochno-Karabairskaya | 8 | 2.5 | 10 |
| 14 | Severnyy Paleokarachukur | 2.6 | 2.9 | 30 |
| 15 | Tsentral'nyy Paleokarachukur | 6.2 | 1.2 | 25 |
| 16 | Yugo-Vostochnyy Pamuk | 6.5 | 3.5 | 10 |

Note: The dimensions of the paleofolds are indicated according to the exterior locking isopach, and the height is according to the washout.

For the purpose of evaluating the paleostructures as possible targets for exploratory work at the first stage it is necessary to carry out a more detailed analysis of the appropriate seismic materials, and also to use the data of deep wells on neighboring sections with the conduct where necessary of additional detailed seismic research. In the case of a positive conclusion the organization of exploratory drilling is necessary.

The location of the basic paleostructures is indicated in the illustration.

Such elevations are being prospected successfully in other old oil regions of the country and it should be assumed that in Western Uzbekistan also they should attract attention as new targets for searches for oil and gas.

Submitted 20 September 1978



10908
CSO: 1822

END